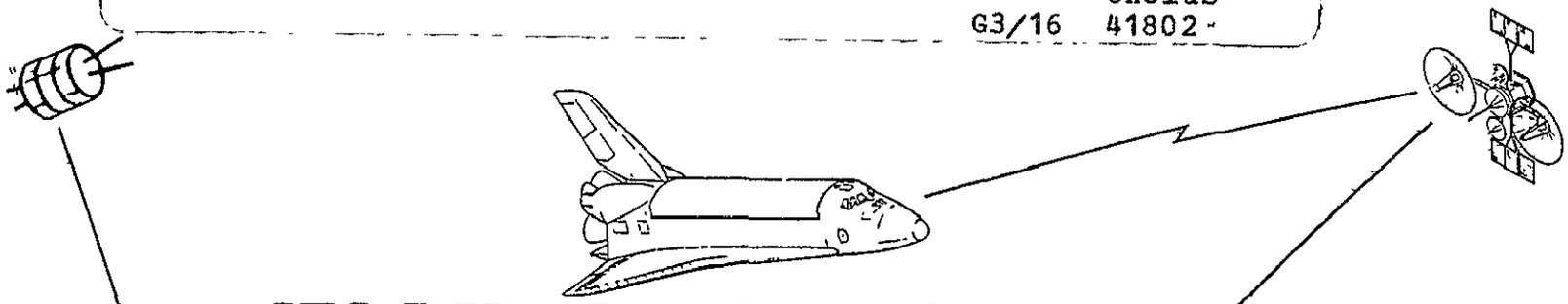


STS PAYLOADS MISSION CONTROL STUDY

EXECUTIVE SUMMARY BRIEFING

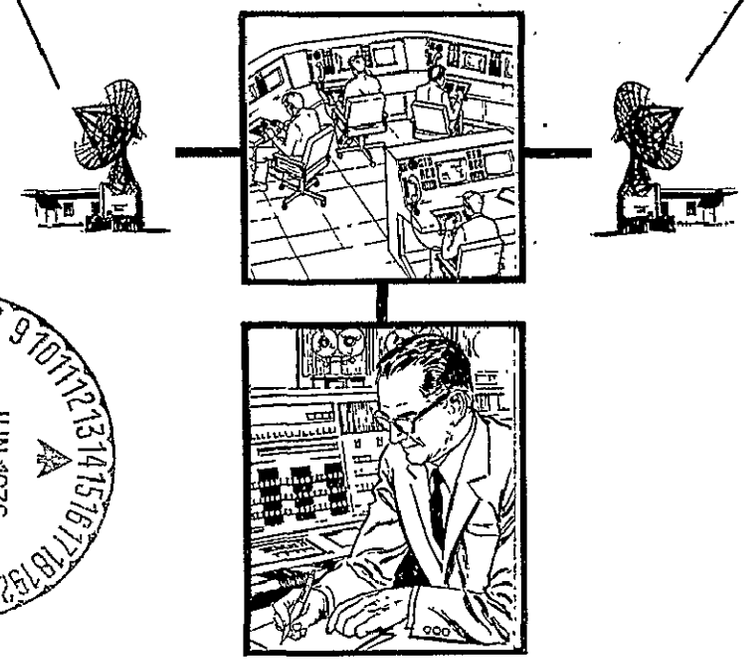
CONTRACT NAS 9-14484

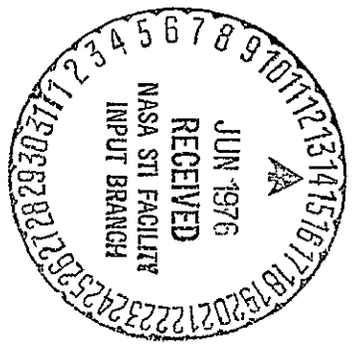
PREPARED FOR
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TEXAS

PRESENTED TO

NASA HEADQUARTERS
OFFICE OF SPACEFLIGHT

December 1975





TRW
SYSTEMS GROUP

STS PAYLOADS MISSION CONTROL STUDY

EXECUTIVE SUMMARY BRIEFING

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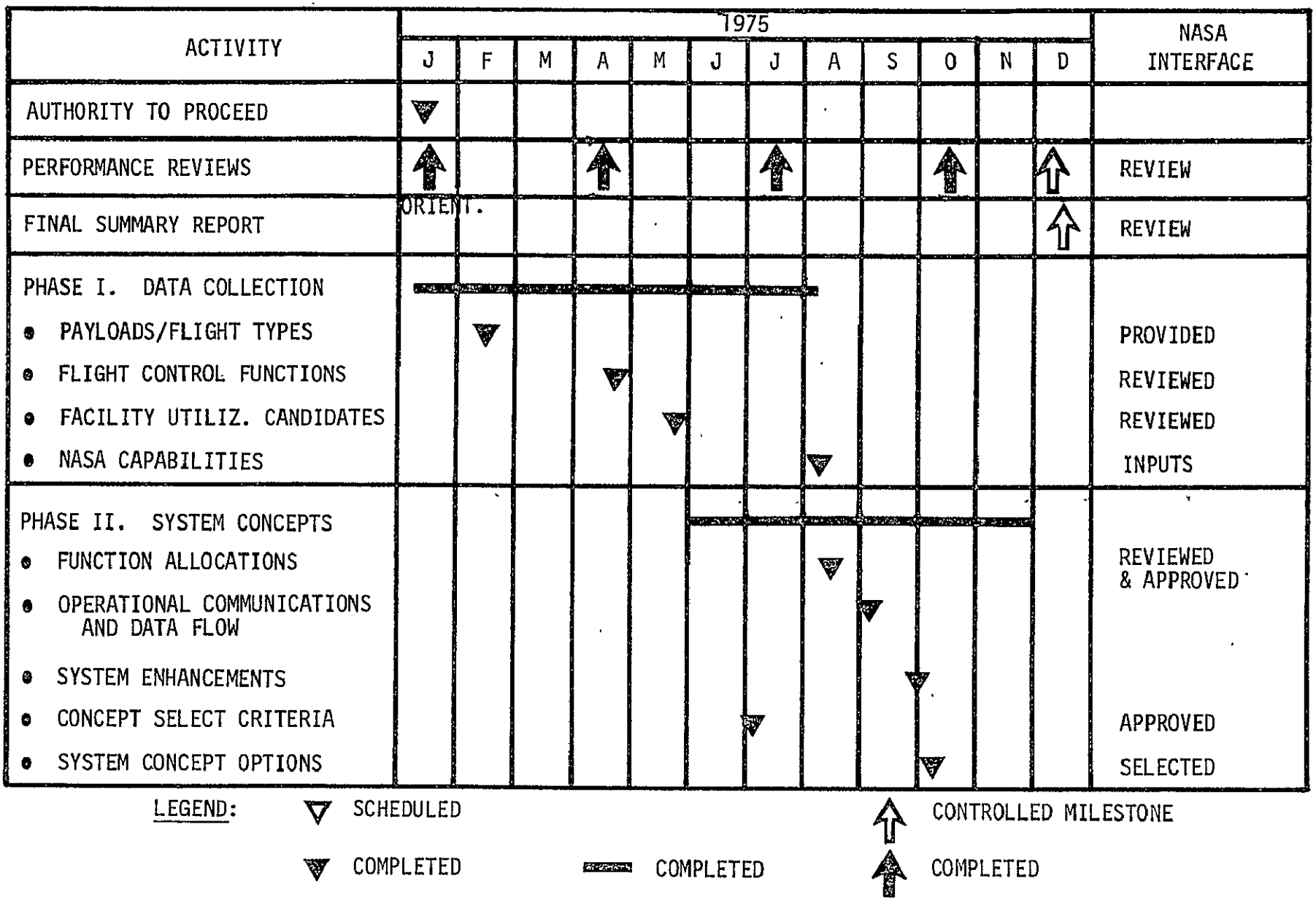
TRW
SYSTEMS GROUP

PRESENTATION OUTLINE

- STUDY-BACKGROUND
- OVERALL STUDY CONCLUSIONS
- SCOPE OF INVESTIGATIONS
- SYSTEM CONCEPT OPTIONS
- PAYLOAD OPERATIONS IMPLEMENTATION GUIDELINES

STUDY BACKGROUND

STUDY SCHEDULE



STS PAYLOADS MISSION CONTROL STUDY

STUDY OBJECTIVES

- IDENTIFY FLIGHT CONTROL GROUND FUNCTIONS FOR REPRESENTATIVE STS PAYLOADS, (REQUIREMENTS)
- INVESTIGATE PRESENT/PLANNED NASA-WIDE FACILITIES, (CAPABILITIES), FOR STS PAYLOAD CONTROL
- DETERMINE FEASIBLE, COST EFFECTIVE SYSTEM CONCEPT OPTIONS FOR FLIGHT CONTROL OF STS PAYLOADS
- DEVELOPMENT IMPLEMENTATION GUIDELINES FOR PROPOSED SYSTEM CONCEPT OPTION(S)

STUDY GUIDELINES

- STUDY ADDRESSES REAL TIME OPERATIONS OF STS PAYLOADS DURING OPERATIONAL STS PHASE
- STUDY EMPHASIZES PAYLOAD OPERATIONS DURING FLIGHT PHASES INVOLVING STS/PAYLOAD INTERACTION
- EXISTING NASA CAPABILITIES POINT OF DEPARTURE FOR THIS STUDY
- EMPHASIZE REQUIREMENTS FOR GROUND SUPPORT OF FLIGHT CONTROL FUNCTIONS
- POCC'S AND MCC-H SHARE RESPONSIBILITY FOR PAYLOAD AND STS
- POCC HAS FULL RESPONSIBILITY FOR ITS PAYLOAD DURING SEPARATE FREE-FLIGHT OPERATION
- NASA PAYLOAD OPERATIONS CENTERS (POC'S) PROVIDE HOST FACILITIES OR OPERATIONAL INTERFACES WITH CUSTOMERS
- USE UPDATED TRAFFIC MODEL PROVIDED BY THE COR, 4 JUNE 1975

OVERALL STUDY CONCLUSIONS

SUMMARY CONCLUSIONS

- AN EVOLUTIONARY APPROACH TO AN INTEGRATED, STANDARDIZED MULTI-CENTER SYSTEM FOR STS PAYLOADS IS INDICATED FOR JOINT STS/PAYLOAD OPERATIONAL FLIGHT PHASES
  - PERMITS POOLING RESOURCES
  - ELIMINATED UNNECESSARY REDUNDANCY
  - REDUCES COST

- ULTIMATE SYSTEM MAXIMIZES STANDARDIZATION OF POCC'S FOR ALL PAYLOADS
  - ALLOW USE OF STANDARD SOFTWARE
  - PROMOTE SYSTEM VERSATILITY
  - ACCOMMODATE FAST TURN-AROUND
  - SIMPLIFY SPARES, MAINTENANCE

- EARLY PROGRAM NEEDED TO ESTABLISH STANDARDS FOR STS PAYLOADS
  - WILL PERMIT USE OF PROCESSING FIRMWARE
  - WILL MINIMIZE UNIQUE SOFTWARE
  - WILL SIMPLIFY PROCEDURES, DOCUMENTATION
  - WILL REDUCE TRAINING TIME

SUMMARY CONCLUSIONS (CONTINUED)

- KEY DECISION POINT -- EXPANDED TRI-CENTER SYSTEM VERSUS ADDITIONAL CENTERS
  - AFFECTS LONG RANGE SYSTEM ARCHITECTURE
  - INFLUENCES USER INTERFACES

- PORTABLE, INTERACTIVE POCC/DOMSAT TERMINAL APPEARS TO BE PRACTICAL ALTERNATIVE FOR SPECIFIC USERS
  - ENHANCES USER INVOLVEMENT
  - IMPROVES SYSTEM UTILITY FOR USERS
  - MOVES DATA, NOT PEOPLE

- GSFC POCCNET CONCEPT IS FEASIBLE FOR ALL POCC'S
  - ADAPTS TO USE OF EXISTING/PLANNED CAPABILITIES
  - PERMITS NETTING OF CENTERS
  - PROMOTES STANDARDIZATION

SCOPE OF INVESTIGATIONS

FLIGHT CONTROL GROUND FUNCTIONS

OBJECTIVE: IDENTIFY FLIGHT CONTROL FUNCTIONS FOR GIVEN STS PAYLOAD FLIGHT TYPES AND ALLOCATE ONBOARD/GROUND

SUMMARY RESULTS:

- REPRESENTATIVE PAYLOAD FLIGHT TYPES WERE ESTABLISHED BY NASA AND DOCUMENTED BY STUDY TEAM
- DESCRIPTIONS AND CHARACTERISTICS OF SELECTED PAYLOADS DOCUMENTED
- FLIGHT CONTROL FUNCTIONS FOR EACH PAYLOAD IDENTIFIED AND DOCUMENTED BY APPLICABLE FLIGHT PHASES
- FLIGHT CONTROL FUNCTIONS ALLOCATED (1) ONBOARD, (2) GROUND, OR (3) BOTH ONBOARD AND GROUND

REPRESENTATIVE PAYLOADS AND FLIGHT TYPES

FLIGHT TYPE I.D. / FLIGHT TYPE / PAYLOAD SPONSOR	A	B	C	D
	SPACELAB			
	MODULE & PALLET DEDICATED DISCIPLINE	MODULE & PALLET MULTI-DISCIPLINE	PALLET ONLY DEDICATED DISCIPLINE	PALLET ONLY MULTI-DISCIPLINE
ARC				
GSFC			SOLAR PHYSICS (SO)	SO
JPL				
JSC		AMPS		SEOPS
LaRC	ATL			
MSFC		AMPS (LEAD CENTER)		HEA (LEAD CENTER)
OTHER U.S. AGENCIES				
COMMERCIAL				
INTERNATIONAL		SPACE PROCESSING (SP)		

REPRESENTATIVE PAYLOADS AND FLIGHT TYPES

FLIGHT TYPE I.D.	E	F	G	H	I	J	
FLIGHT TYPE / PAYLOAD SPONSOR	LOW EARTH ORBIT						
	SINGLE CARGO				MULTI-CARGO		
	DELIVERY	DELIVERY & RETRIEVAL	REVISIT/ SERVICE W/O EVA	REVISIT/ SERVICE W/EVA	DELIVERY	SPACELAB MODULE ONLY DEDICATED DISCIPLINE	DELIVERY
ARC					LS MODULE (BESS)	LS	
GSFC	EOS	LST/SI	EOS				EXPLORER
JPL							
JSC					SEOPS	LS (LEAD CENTER)	
LaRC							
MSFC		*		LST	2 MINI-LAGEOS FFTO		
OTHER U.S. AGENCIES							STP (DOD)
COMMERCIAL							
INTERNATIONAL							

*LST (LEAD CENTER) HEAO C RETRIEVAL

REPRESENTATIVE PAYLOADS AND FLIGHT TYPES

FLIGHT TYPE I.D.	K	L	M	N
FLIGHT TYPE	IUS		TUG	
PAYLOAD SPONSOR	MULTI-SATELLITE	PLANETARY	MULTI-SATELLITE	PLANETARY
ARC				PIONEER
GSFC				
JPL		MARINER		
JSC				
LaRC				
MSFC				
OTHER U.S. AGENCIES	DISASTER WARNING (NOAA)		TRAFFIC MANAGEMENT (FAA)	
COMMERCIAL			INTEL/SAT	
INTERNATIONAL	COMM/SAT			

TYPES AND LOCATIONS OF PARTIES INVOLVED

OBJECTIVE: CHARACTERIZE NASA PAYLOAD DEVELOPMENT CENTERS FOR FLIGHT CONTROL OPERATIONS AND EVALUATE CANDIDATE FACILITY UTILIZATION CONCEPTS

SUMMARY RESULTS:

- DETERMINED NASA CENTERS' INVOLVEMENT IN PAYLOAD DEVELOPMENT AND MISSION OPERATIONS AND DOCUMENTED FINDINGS BY CENTER AND FLIGHT TYPE

- IDENTIFIED PRELIMINARY FACILITY UTILIZATION CONCEPTS FOR PAYLOAD FLIGHT CONTROL, RANGING FROM CENTRALIZED TO DECENTRALIZED CONCEPTS

ALTERNATIVES FOR POC LOCATIONS

MISSION TYPES	EXISTING SINGLE POC	MULTIPLE POC'S	EACH DEVELOPMENT CENTER IS POC
AUTOMATED EARTH ORBIT	GSFC JSC	GSFC, JSC GSFC, MSFC, ARC JSC, MSFC, GSFC	GSFC, MSFC, JSC, ARC, JPL
AUTOMATED PLANETARY	JPL ARC * *REMOTE POC FOR PIONEER	JPL, ARC	JPL, ARC, LaRC
SPACELAB	JSC JPL GSFC	JSC, MSFC JSC, JPL JSC, GSFC JSC, JPL, GSFC JSC, JPL, GSFC, MSFC	JSC, JPL, MSFC, GSFC, ARC, LaRC

PRESENT/PLANNED NASA-WIDE CAPABILITIES

OBJECTIVE: EVALUATE AND DOCUMENT NASA-WIDE PRESENT AND PLANNED CAPABILITIES FOR FLIGHT CONTROL OF STS PAYLOADS

SUMMARY RESULTS:

- GUIDELINES FOR DATA COLLECTION AND ASSESSMENT ESTABLISHED
- SEVEN NASA CENTERS VISITED AND THEIR CAPABILITIES DOCUMENTED

  APPENDIX A - ARC
  APPENDIX B - GSFC
  APPENDIX C - JPL
  APPENDIX D - JSC
  APPENDIX E - KSC
  APPENDIX F - LaRC
  APPENDIX G - MSFC

- GENERAL DOCUMENT DEFINES GUIDELINES, FUNCTIONAL CATEGORIES FOR DATA COLLECTION AND SUMMARIZES RESULTS
- SEVEN FUNCTIONAL CATEGORIES DOCUMENTED FOR EACH CENTER
  - GENERAL PAYLOAD INVOLVEMENT, OPERATIONAL MODES
  - CONTROL CENTER AND/OR MONITORING CAPABILITIES
  - TRACKING AND DATA ACQUISITION CAPABILITIES
  - COMMUNICATIONS AND DATA HANDLING CAPABILITIES
  - COMPUTATION AND DATA MANAGEMENT CAPABILITIES
  - PAYLOAD TRAINING AND SIMULATION CAPABILITIES
  - PAYLOAD HOST FACILITIES

ALLOCATION OF FLIGHT CONTROL GROUND FUNCTIONS

OBJECTIVE: ALLOCATE PAYLOAD FLIGHT CONTROL GROUND FUNCTIONS BETWEEN THE PAYLOAD OPERATOR AND STS OPERATOR

SUMMARY RESULTS:

- ESTABLISHED 15 FLIGHT PHASES APPLICABLE TO THE 14 GIVEN FLIGHT TYPES
- GENERAL GUIDELINES DEVELOPED FOR ALLOCATION OF THE FLIGHT CONTROL GROUND FUNCTIONS
- 666 FLIGHT CONTROL GROUND FUNCTIONS HAVE BEEN IDENTIFIED AND ALLOCATED TO ONE OF FIVE CATEGORIES:
  - PAYLOAD OPERATOR
  - PAYLOAD OPERATOR WITH STS OPERATOR COGNIZANCE (MONITOR)
  - PAYLOAD OPERATOR AND STS OPERATOR
  - STS OPERATOR WITH PAYLOAD OPERATOR COGNIZANCE (MONITOR)
  - STS OPERATOR
- ON SPACELAB FLIGHTS, STS AND PAYLOAD OPERATORS ARE BOTH INVOLVED DURING ENTIRE FLIGHT
- FOR AUTOMATED EARTH ORBIT AND PLANETARY FLIGHTS, STS AND PAYLOAD OPERATIONS INTERFACES ARE SHORT COMPARED TO THE LONG DURATION "POCC ONLY" OPERATIONS

GENERAL GUIDELINES FOR GROUND FUNCTION ALLOCATION

FUNCTION ASSIGNEE	APPLICABLE GUIDELINES
PAYLOAD OPERATOR	• PAYLOAD FUNCTIONS WHILE IN FREEFLYING MODE (NOT ATTACHED TO ORBITER OR IUS/TUG) • NON-HAZARDOUS PAYLOAD EXPERIMENTS FUNCTIONS (PAYLOAD ATTACHED TO STS ELEMENT) • PAYLOAD/SUPPORT FUNCTIONS NOT REQUIRING STS
PAYLOAD OPERATOR W/STS OPERATOR COGNIZANCE	• PAYLOAD EXPERIMENT FUNCTIONS INVOLVING POTENTIAL HAZARD TO STS • PAYLOAD FUNCTION UTILIZES STS CONSUMABLES • PAYLOAD FUNCTION IMPACTS STS TIMELINES • CRITICAL PAYLOAD FUNCTIONS MONITORING • GO/NO-GO FOR CONTINUING FLIGHT • PAYLOAD EXPERIMENT FAULT ANALYSIS
PAYLOAD OPERATOR AND STS OPERATOR	• HANDOVER FUNCTIONS BETWEEN STS-PAYLOAD OPERATORS • OTHER FUNCTIONS INVOLVING JOINT STS-PAYLOAD OPERATOR ACTIVITY • FUNCTIONS THAT MUST BE PERFORMED BY BOTH STS AND PAYLOAD OPERATORS (CONSUMABLES MANAGEMENT)
STS OPERATOR W/PAYLOAD OPERATOR COGNIZANCE	• STS SUBSYSTEMS OPERATIONS THAT SUPPORT OR SERVICE PAYLOAD OPERATIONS, SUCH AS TRAJECTORY POSITIONING AND POINTING • STS OPERATOR FUNCTIONS REQUIRING SUPPORT OF PAYLOAD OPERATOR, SUCH AS VERIFICATION OF THE CENTER COMMUNICATIONS INTERFACES
STS OPERATOR	• POWERED FLIGHT • SAFETY MONITORING • SERVICE FUNCTIONS TO PAYLOAD OPERATOR, SUCH AS CARGO BAY ENVIRONMENT MONITORING, VERIFYING ORBITER-PAYLOAD CONNECTIONS, ETC. • STANDARD (REPETITIVE) SERVICE FUNCTIONS, SUCH AS DATA TRANSMISSIONS • STS FUNCTIONS REQUIRED TO EFFECT REQUIRED CONDITIONS FOR PAYLOAD OPERATIONS

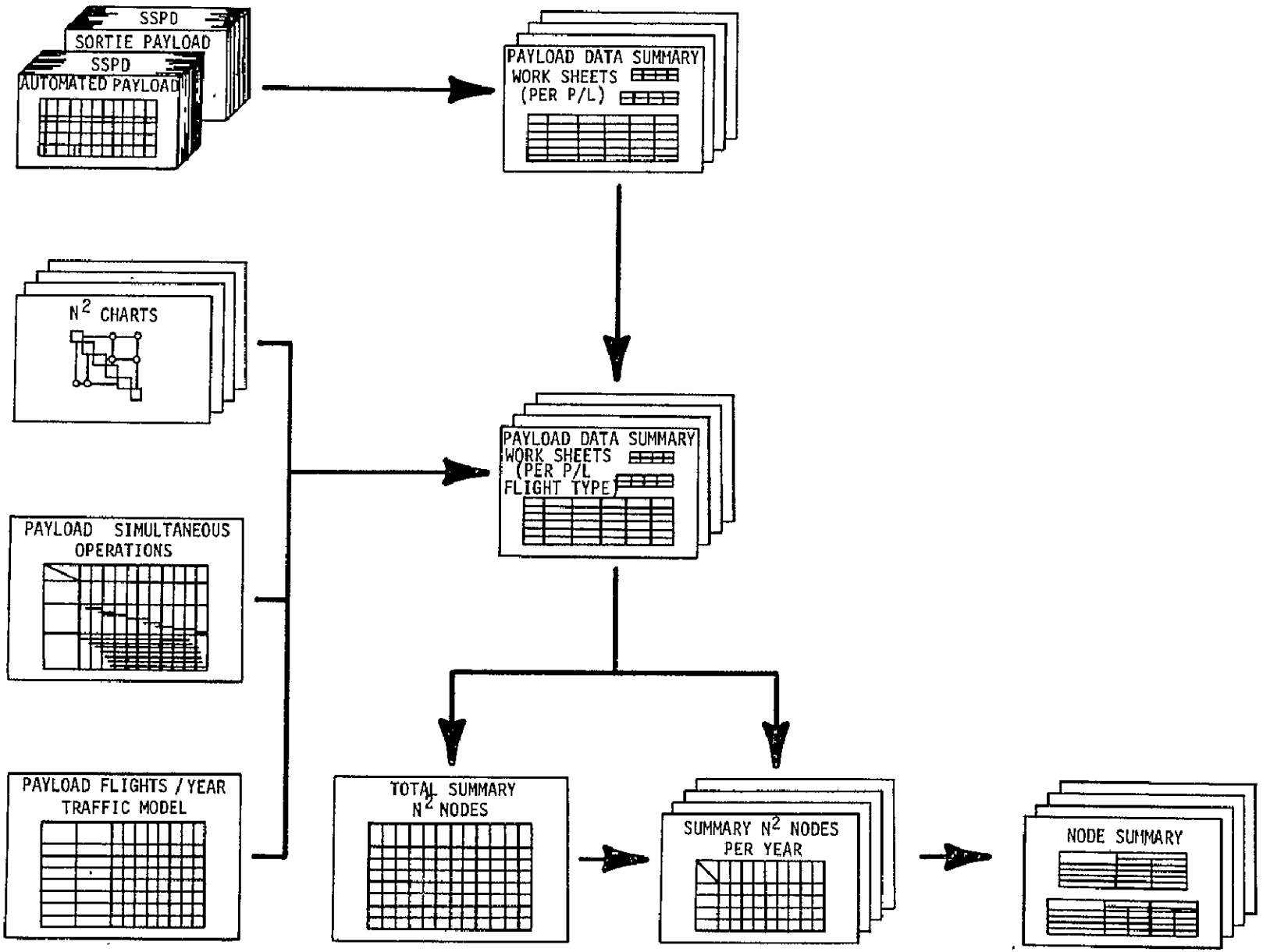
OPERATIONAL INFORMATION FLOW AND PROCESSING

OBJECTIVE: DEVELOP A MODEL AND METHODOLOGY TO IDENTIFY COMMUNICATIONS CHANNELS AND DATA PROCESSING REQUIREMENTS BETWEEN STS PAYLOAD FLIGHT CONTROL ELEMENTS

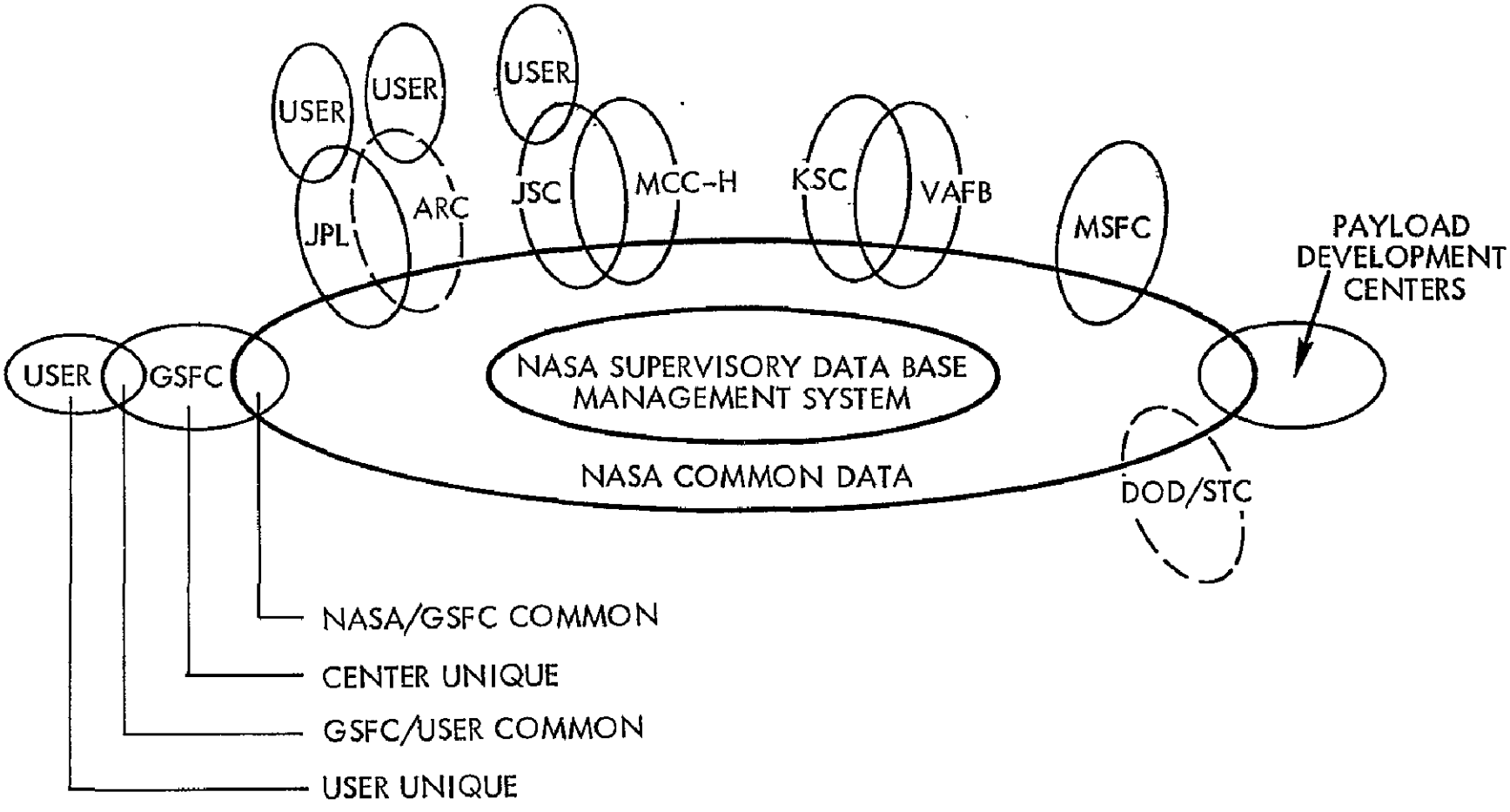
SUMMARY RESULTS:

- PUBLISHED METHODOLOGY AND MODEL FOR DERIVING COMMUNICATION AND DATA PROCESSING TRAFFIC LEVELS
- DETERMINED FEASIBLE SUPERVISORY DATA BASE SYSTEM FOR STS PAYLOAD FLIGHT CONTROL
- IDENTIFIED SYSTEM ENHANCEMENT REQUIREMENTS

APPLICATION OF MODEL FOR COMMUNICATION TRAFFIC FLOW



STS/PAYLOAD SUPERVISORY DATA BASE CONCEPT



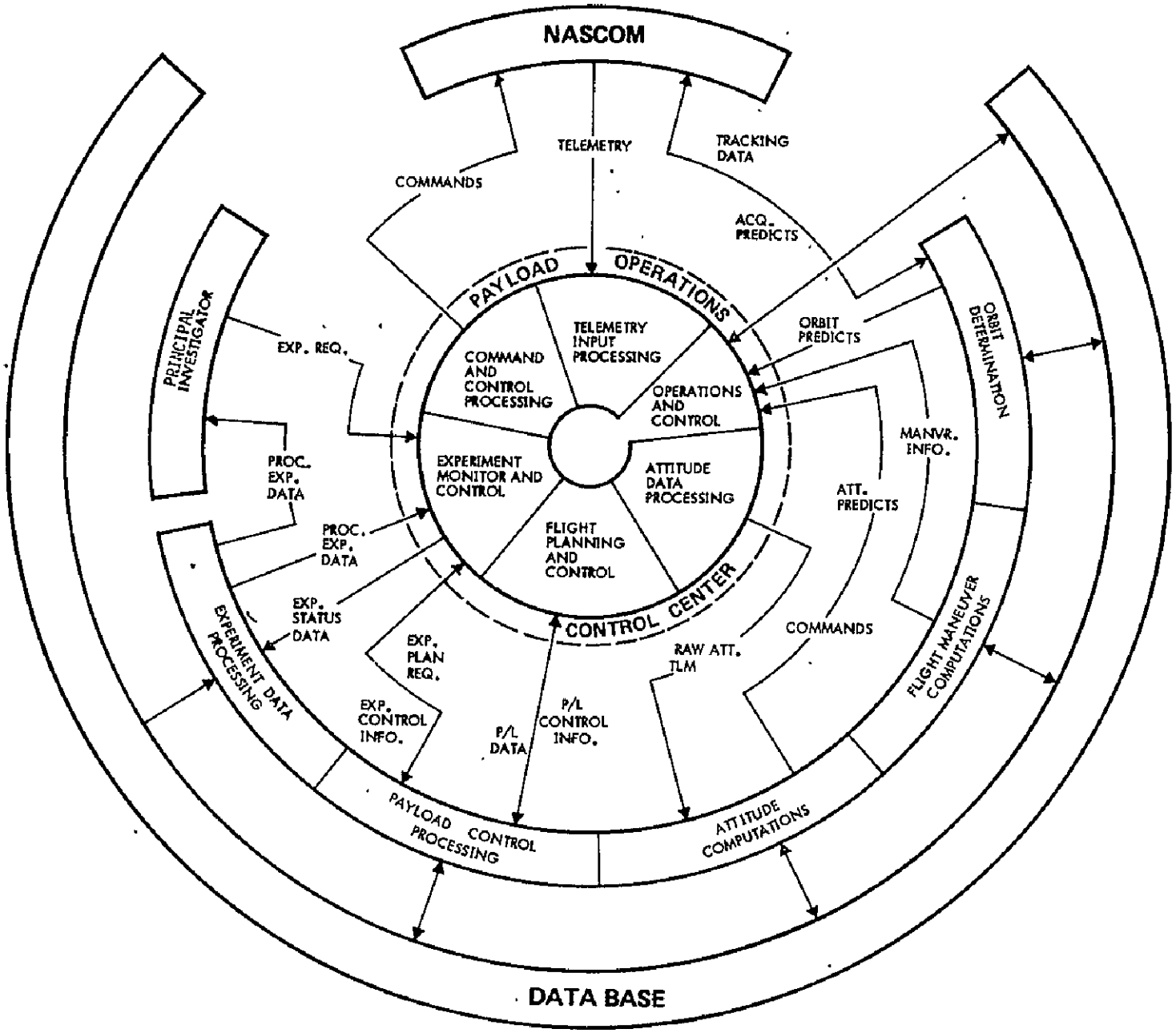
DEFINITION OF SYSTEM CONCEPTS

OBJECTIVE: DEFINE FEASIBLE, COST EFFECTIVE FLIGHT CONTROL SYSTEM CONCEPTS FOR PAYLOADS. DEVELOP IMPLEMENTATION GUIDELINES

SUMMARY RESULTS:

- POCC FUNCTIONS, INTERFACES AND IMPLEMENTATION APPROACHES WERE EXAMINED
- THREE SYSTEM CONCEPT OPTIONS WERE DEFINED
- IMPLEMENTATION GUIDELINES INCLUDE:
  - 4 PHASE APPROACH TO SATISFACTION OF ULTIMATE REQUIREMENTS
  - EVOLUTIONARY APPROACH INVOLVING LOGICAL SEQUENCE
  - KEY DECISION POINTS ARE IDENTIFIED

TYPICAL POC FUNCTIONAL FLOW

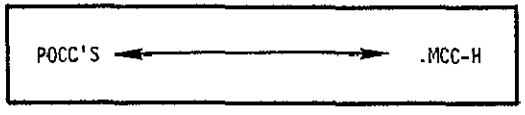


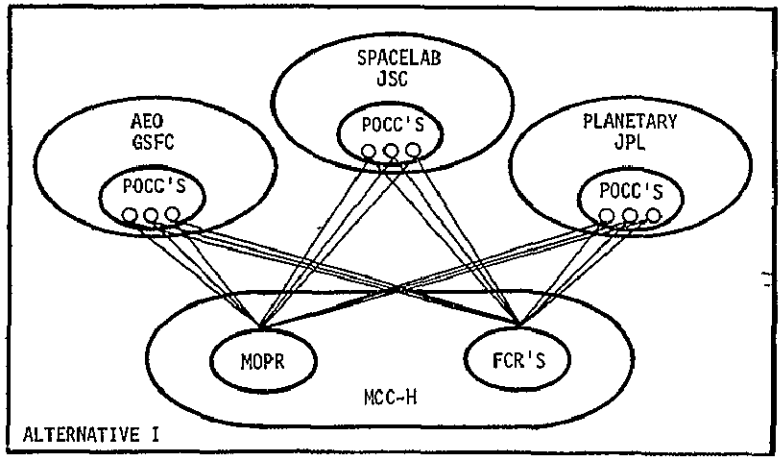
PAYLOAD OPERATIONAL INTERFACE ALTERNATIVES
JOINT STS/PAYLOAD OPERATIONAL PHASES

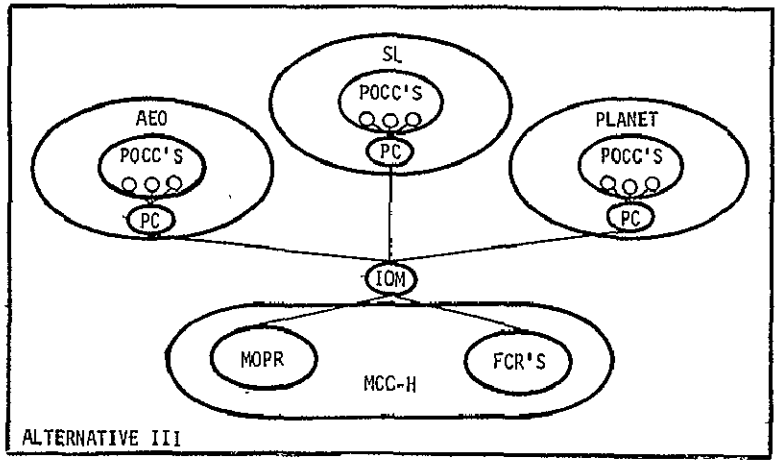
MAJOR INTERFACES

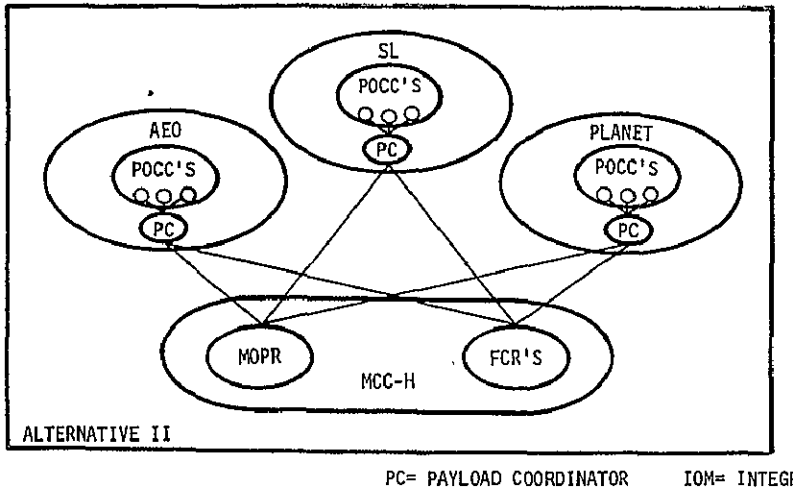
- POCC'S ⟷ MCC-H
- POCC'S ⟷ NETWORKS (STDN, DSN)
- POCC'S ⟷ LAUNCH AND LANDING SITES
- POCC'S ⟷ USERS/NASA DEVELOPMENT CENTERS
- POCC'S ⟷ ENGINEERING SUPPORT TEAMS
- POCC'S ⟷ SCIENCE/USER SUPPORT TEAMS

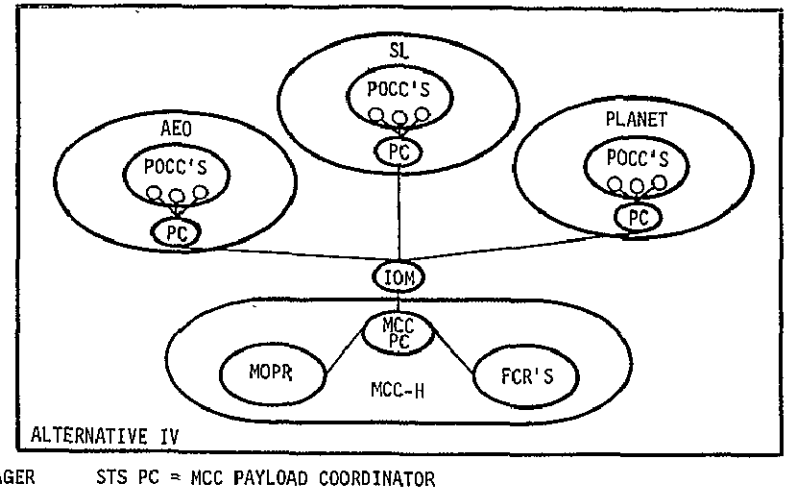
PAYLOAD OPERATIONAL INTERFACE ALTERNATIVES
JOINT STS/PAYLOAD OPERATIONAL PHASES





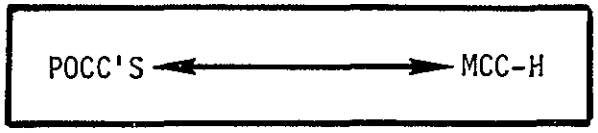






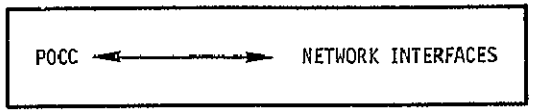
PC= PAYLOAD COORDINATOR IOM= INTEGRATED OPERATIONS MANAGER STS PC = MCC PAYLOAD COORDINATOR

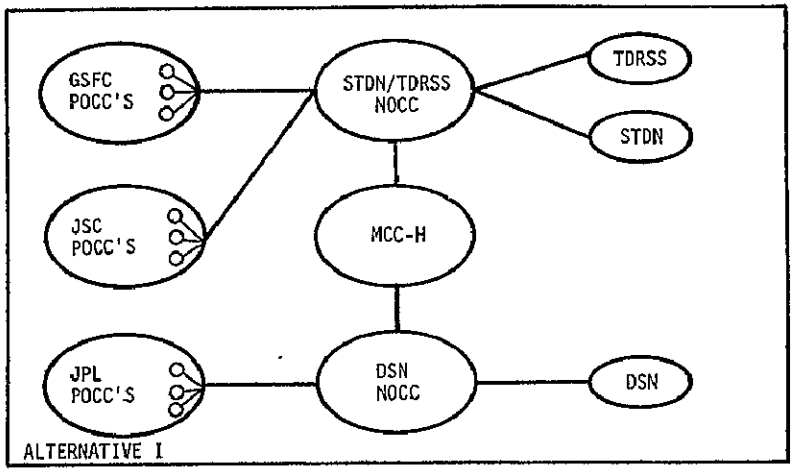
PAYLOAD OPERATIONAL INTERFACE ALTERNATIVES
JOINT STS/PAYLOAD OPERATIONS PHASES

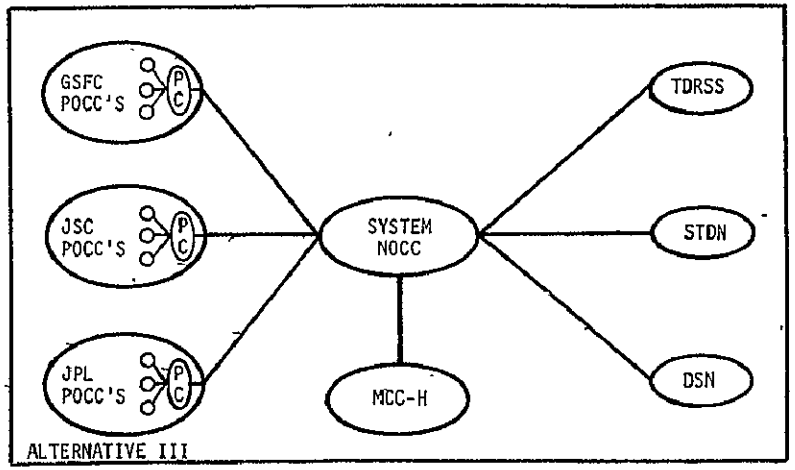


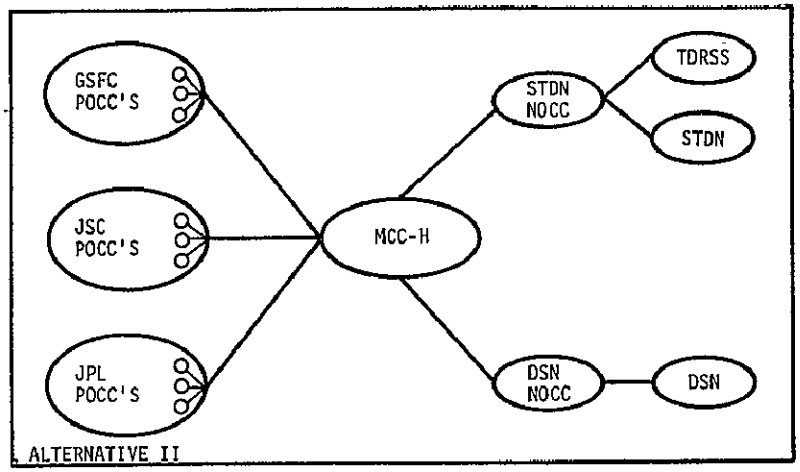
ALTERNATIVES	ADVANTAGES	DISADVANTAGES
I - EACH POCC TO MOPR AND FCR	• MOST DIRECT INTERFACES	• MULTIPLICITY OF INTERFACES COMPLICATES STANDARDIZATION
II - PAYLOAD CLASS COORDINATOR (PC) INTERFACES POCCs OF EACH CLASS WITH MOPR AND FCR	• ADDITION OF PAYLOAD COORDINATORS (PC'S) PROVIDES SINGLE POINT CONTACT FOR MCC-H	• PC'S INTERFACE WITH SEPARATE PARTS OF MCC-H ORGANIZATION
III - INTEGRATED OPERATIONS MANAGER (IOM) INTERFACES POCCs VIA PC, WITH MOPR AND FCR	• ADDITION OF INTEGRATED OPERATIONS MANAGER (IOM) FURTHER ENHANCES STANDARDIZED OPERATION	• ADDITION OF IOM LENGTHENS LINES OF COMMUNICATION BETWEEN POCC'S AND MCC-H
IV - MCC PAYLOAD COORDINATOR INTERFACES MOPR AND FCR WITH IOM	• MINIMUM NUMBER OF SEPARATE INTERFACES	• WITH ADDITION OF MCC PAYLOAD COORDINATOR, COMMUNICATIONS LINES BETWEEN POCC'S AND MCC-H ARE LONGEST

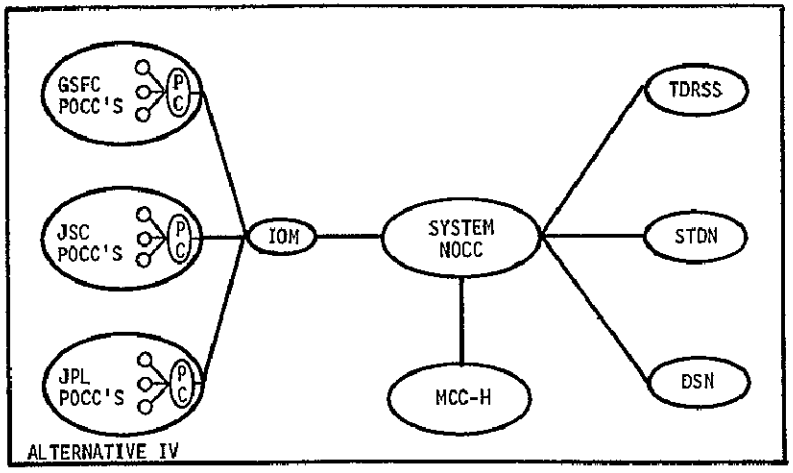
PAYLOAD OPERATIONAL INTERFACE ALTERNATIVES
JOINT STS/PAYLOAD OPERATIONAL PHASES









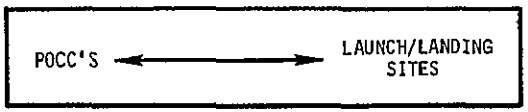


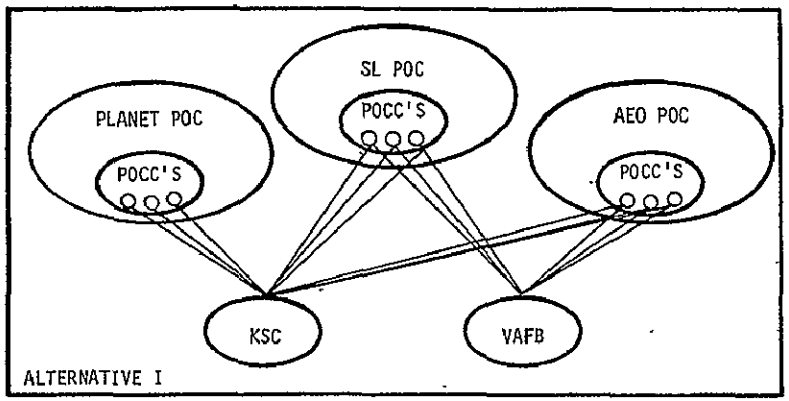
PAYLOAD OPERATIONAL INTERFACE ALTERNATIVES
JOINT STS/PAYLOAD OPERATIONAL PHASES

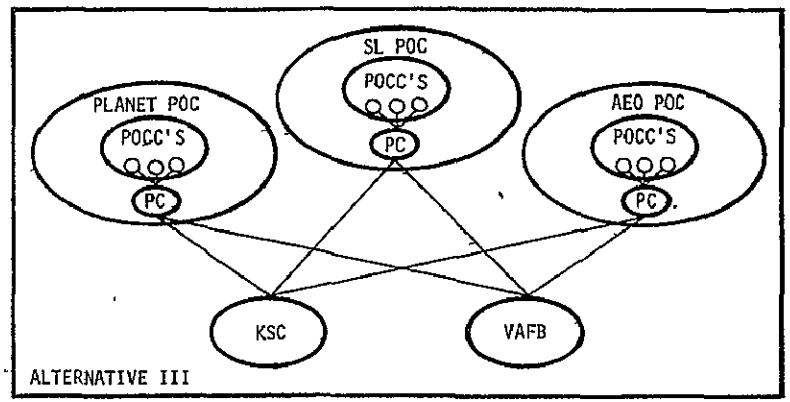
POCC'S ⟷ NETWORK INTERFACES

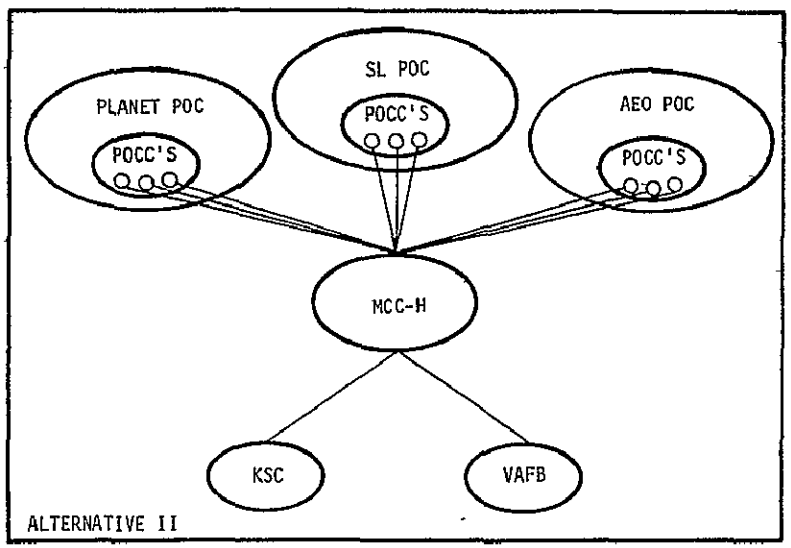
ALTERNATIVES	ADVANTAGES	DISADVANTAGES
I - POCCs INTERFACE DIRECTLY WITH THE APPROPRIATE NETWORK CONTROLLER	• EACH POCC DEALS DIRECTLY WITH ITS NETWORK CONTROLLER AT ALL TIMES	• NETWORK OPERATIONS CONTROL CENTER MUST RESOLVE CONFLICTING REQUIREMENTS
II - POCCs INTERFACE WITH APPROPRIATE NETWORK CONTROLLER VIA MCC-H	• EXISTING NOCC'S DEAL ONLY WITH MCC-H DURING JOINT OPERATIONS	• PLACES THE BURDEN ON MCC-H TO COORDINATE POCC NETWORK REQUIREMENTS FOR JOINT OPERATIONS
III - POCCs INTERFACE WITH A SYSTEM NOCC VIA A PAYLOAD COORDINATOR	• MERGING NOCC FUNCTIONS UNDER A SINGLE SYSTEM NOCC WILL ELIMINATE REDUNDANT FUNCTIONS AND REDUCE OPERATING COSTS	• SYSTEM NOCC MUST COORDINATE SIMULTANEOUS REQUIREMENTS OF THREE PAYLOAD CLASSES AND MCC-H
IV - POCCs INTERFACE WITH A SYSTEM NOCC VIA THE PAYLOAD CONTROLLER AND THE IOM	• ADDITION OF INTEGRATED OPERATIONS MANAGER (IOM) MINIMIZES INTERFACES WITH SYSTEM NOCC AND SIMPLIFIES RESOLUTION OF CONFLICTING REQUIREMENTS	• THE ADDITION OF THE IOM LENGTHENS THE LINE OF COMMUNICATIONS BETWEEN THE POCC'S AND THE NETWORKS

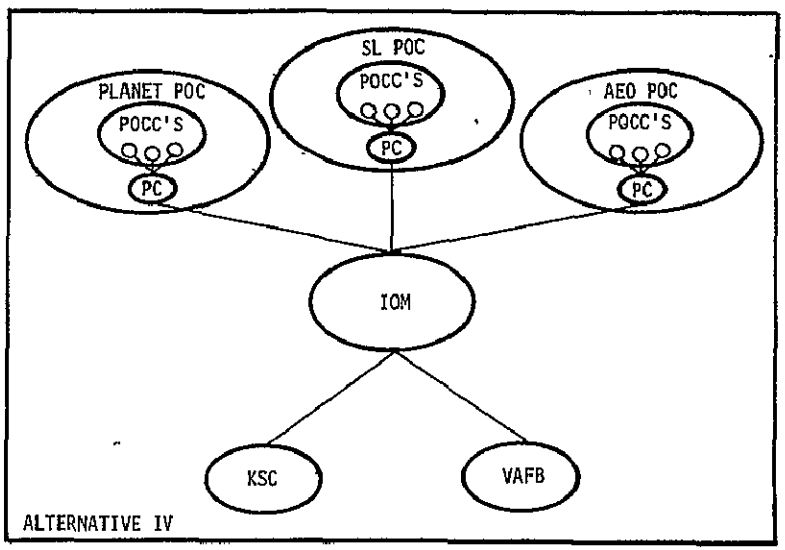
PAYLOAD OPERATIONAL INTERFACE ALTERNATIVES
JOINT STS/PAYLOAD OPERATIONAL PHASES











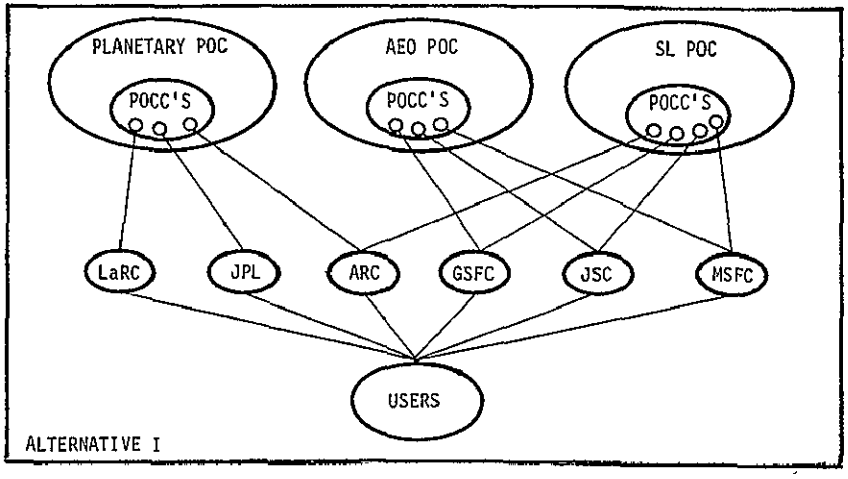
LEGEND PC = PAYLOAD COORDINATOR IOM = INTEGRATED OPERATIONS MANAGER

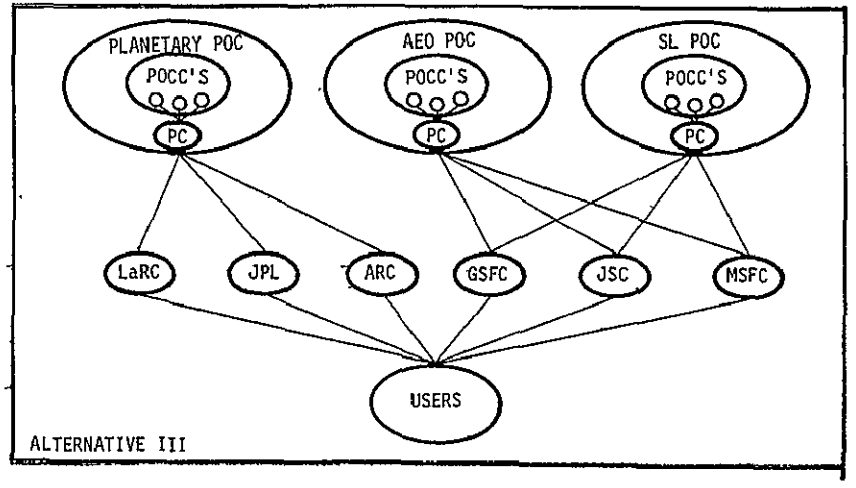
PAYLOAD OPERATIONAL INTERFACE ALTERNATIVES
JOINT STS/PAYLOAD OPERATIONAL PHASES

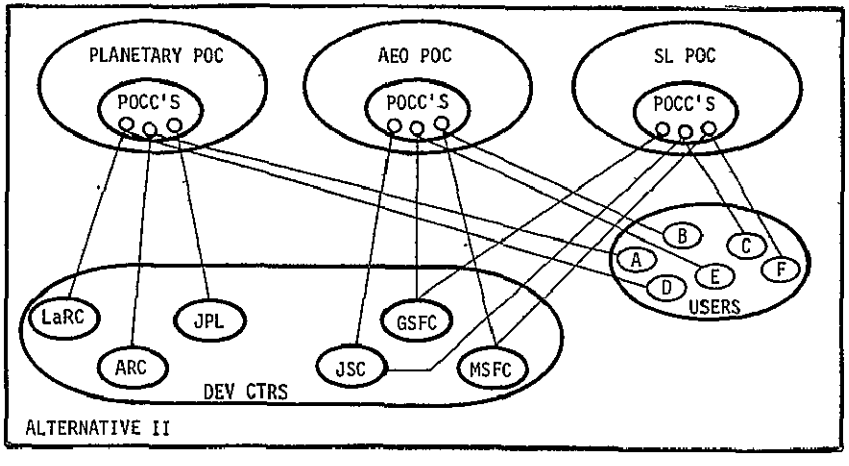
POCC'S ⟷ LAUNCH/LANDING SITES

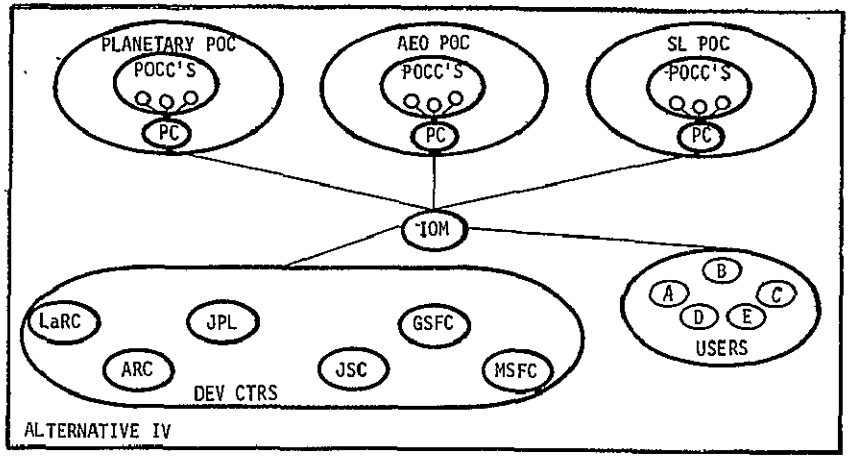
ALTERNATIVES	ADVANTAGES	DISADVANTAGES
I - ANY POCC TO ITS' LAUNCH/LANDING SITE DIRECTLY	• INDIVIDUAL POCC'S WORK DIRECTLY WITH LAUNCH/LANDING SITES	• MULTIPLICITY OF INTERFACES MAKES STANDARDIZATION OF OPERATIONS DIFFICULT
II - ANY POCC TO ITS' LAUNCH/LANDING SITE VIA MCC-H	• POCC'S WORK WITH LAUNCH/LANDING SITE THROUGH MCC-H DURING JOINT OPERATIONS THUS REDUCING TOTAL INTERFACES FOR LAUNCH/LANDING SITES	• PLACES BURDEN ON MCC-H TO COORDINATE POCC'S REQUIREMENTS WITH L/L SITES
III - PAYLOAD COORDINATORS INTERFACE POCC'S WITH LAUNCH/LANDING SITES	• ADDITION OF PAYLOAD COORDINATOR REDUCES INTERFACES AND ENHANCES STANDARDIZATION	• LAUNCH/LANDING SITES WILL HAVE SEPARATE INTERFACE WITH MCC-H AND POCC VIA PC FOR EACH PRELAUNCH/LAUNCH OPERATION
IV - PAYLOAD COORDINATORS INTERFACE POCC'S WITH LAUNCH/LANDING SITES VIA THE INTEGRATED OPERATIONS MANAGER	• ADDITION OF INTEGRATED OPERATIONS MANAGER (IOM) REDUCES TOTAL PAYLOAD INTERFACES WITH L/L SITES	• LINES OF COMMUNICATION BETWEEN POCC'S AND L/L SITES WILL BE LENGTHENED BY ADDITION OF IOM

PAYLOAD OPERATIONAL INTERFACE ALTERNATIVES
JOINT STS/PAYLOAD OPERATIONAL PHASES









PAYLOAD OPERATIONAL INTERFACE ALTERNATIVES

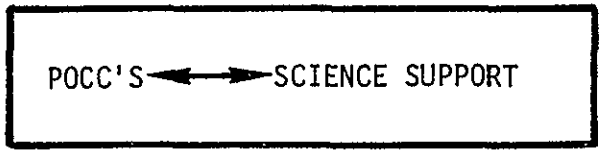
ALTERNATIVES	ADVANTAGES	DISADVANTAGES
I - INDIVIDUAL POCC'S WORK WITH USERS VIA DEVELOPMENT CENTERS	• PROVIDES COORDINATED OPERATIONAL/DESIGN INTERFACE WITH POCC	• USER MAY BECOME ISOLATED FROM THE OPERATION OF HIS PAYLOAD
II - POCC'S WORK DIRECTLY WITH USERS AND DEVELOPMENT CENTERS	• PROVIDES FOR MAXIMUM USER INVOLVEMENT	• POCC MUST COORDINATE OPERATIONAL INPUTS FROM BOTH USERS AND DEVELOPERS
III - PAYLOAD CLASSES ARE COORDINATED BY A PAYLOAD COORDINATOR	• PROVIDES CONTINUITY BETWEEN FLIGHTS OF SIMILAR CLASSES	• USER MAY BE ISOLATED FROM DIRECT INVOLVEMENT IN OPERATION OF HIS PAYLOAD BY PC AND DEVELOPMENT CENTER
IV - AN INTEGRATED OPERATIONS MANAGER STAFF COORDINATES USERS AND DEVELOPMENT CENTERS FOR ALL PAYLOADS	• MAXIMIZES STANDARDIZATION OF STS PAYLOAD OPERATIONS	• IOM STAFF MUST BE VERY LARGE TO CONTAIN SKILLS NECESSARY TO SUPPORT USERS AND DEVELOPMENT CENTERS

PAYLOAD OPERATIONAL INTERFACE ALTERNATIVES

POCC'S ◄► ENGINEERING SUPPORT

ALTERNATIVES	ADVANTAGES	DISADVANTAGES
I - COLOCATE ENGINEERING SUPPORT TEAM AT POC	• COST EFFECTIVE FOR SHORT MISSION WITH LIMITED PERSONNEL	• LIMITS ACCESS TO BASE RESOURCES
II - REMOTE POCC AT DEVELOPMENT CENTER/CONTRACTOR PLANT	• EASY ACCESS TO IN DEPTH ENGINEERING POOL	• COST OF REMOTE POCC • ADDITIONAL OPERATIONAL INTERFACES
III - REMOTE MONITORING BY SUPPORT TEAM WITH DATA TRANSFER	• COST EFFECTIVE FOR LONG DURATION MISSIONS WITH HIGH SUPPORT REQUIREMENTS	• CREATE ADDITIONAL OPERATIONAL INTERFACES

PAYLOAD OPERATIONAL INTERFACE ALTERNATIVES



ALTERNATIVES	ADVANTAGES	DISADVANTAGES
I - COLOCATE SCIENCE SUPPORT TEAM AT POC	• COST EFFECTIVE FOR SHORT MISSION WITH FEW PERSONNEL	• LIMITS ACCESS TO BASE RESOURCES
II - REMOTE POCC AT USER FACILITY	• MAXIMUM EFFICIENCY FOR LONG TERM INTERACTIVE MISSIONS	• COST OF REMOTE POCC • ADDITIONAL OPERATIONAL INTERFACES
III - REMOTE MONITORING BY SUPPORT TEAM WITH DATA TRANSFER	• COST EFFECTIVE FOR LONG DURATION MISSIONS WITH MINIMUM INTERACTION	• ADDITIONAL OPERATIONAL INTERFACES

POSSIBLE POCC IMPLEMENTATION APPROACHES

ALTERNATIVES	APPROACHES
I	POCC/CENTERNET CONCEPT
II	STANDARD POCC'S FOR ALL PAYLOADS
III	DISTRIBUTED CONTROL FOR GENERAL PAYLOAD FUNCTIONS
IV	PRIME POC'S SUPPORT REMOTE POCC'S
V	FULLY CENTRALIZED DEDICATED POCC'S

POSSIBLE POCC IMPLEMENTATION APPROACHES

ALTERNATIVE I - POCCNET/CENTERNET CONCEPT

- ADOPT GSFC POCCNET CONCEPT FOR GSFC, JSC, JPL
- INTEGRATE THREE CENTERS INTO OVERALL CENTER NETWORK
- PROVIDE WIDEBAND DATA TRANSFER VIA DOMSATS TO ENABLE:
  - LEVELING COMPUTER LOADS BETWEEN CENTERS
  - REAL TIME DISPLAY TRANSFER
  - DATA BASE INFORMATION EXCHANGE
  - HIGH SPEED DATAFAX HARD COPY EXCHANGE
- STANDARD SYSTEMS FOR EACH CLASS OF PAYLOAD

POSSIBLE POCC IMPLEMENTATION APPROACHES

ALTERNATIVE II - STANDARD POCCS FOR ALL PAYLOADS

STANDARD FUNCTIONS

- COMMUNICATIONS CONVENTIONS
- TELEMETRY DATA HANDLING FORMATS
- COMMAND SYSTEMS AND FORMATS
- DISPLAY SYSTEMS AND FORMATS
- HARD COPY FORMATS
- DATA BASE MANAGEMENT SYSTEMS
- OPERATOR CONSOLE MODULES
- MAN MACHINE INTERFACES
- OPERATING PROCEDURES AND INTERFACES

UNIQUE FUNCTIONS

- TRACKING DATA ANALYSIS
- PAYLOAD SCIENCE ANALYSIS
- PAYLOAD ENGINEERING ANALYSIS

POSSIBLE IMPLEMENTATION APPROACHES

ALTERNATIVE III - DISTRIBUTED CONTROL FOR GENERAL PAYLOAD FUNCTIONS

- CONTROL OF ALL JOINT OPERATIONS BETWEEN STS AND PAYLOADS MIGHT BE CONCENTRATED AT MCC-H OR AT LAUNCH SITES WITH USER SUPPORT
- ALL PAYLOAD DATA PREPROCESSING, STRIPPING FORMATTING, ROUTING DONE BY DESIGNATED DATA ACQUISITION RESOURCES, PER USER INSTRUCTIONS
- ALL EARTH ORBITER EPHEMERIS AND ATTITUDE COMPUTATION FOR FREE FLYERS DONE BY GSFC; ALL PLANETARY BY JPL
- ALL VIDEO AND SPECIAL ANALOG PROCESSING BY A SINGLE LABORATORY WITH DATA TRANSFER VIA DOMSAT
- DISTRIBUTED DATA BASE SYSTEM UNDER SUPERVISORY CONTROL OF SINGLE CENTER
- ONLY PROGRAM UNIQUE FUNCTIONS PERFORMED BY POCC'S

POSSIBLE POCC IMPLEMENTATION APPROACHES

ALTERNATIVE IV - PRIME CENTERS SUPPORT REMOTE POCC'S

- PORTABLE POCC'S OR REMOTE MONITOR STATIONS WITH DOMSAT TERMINALS SUPPORTED BY POC'S OR POCC'S.

REMOTE POCC FUNCTIONS

- COMMUNICATE WITH POC AND MCC-H VIA DOMSAT
- PERFORMS ALL FLIGHT CONTROL FUNCTIONS
- PERFORMS R.T. TLM PROCESSING
- HANDLES DATA FOR USER BATCH PROCESSING
- HAS ACCESS TO DISTRIBUTED DATA BASES
- PERFORMS ENGINEERING ANALYSIS
- ASSISTS COLOCATED USER IN SCIENCE ANALYSIS

REMOTE MONITOR FUNCTIONS

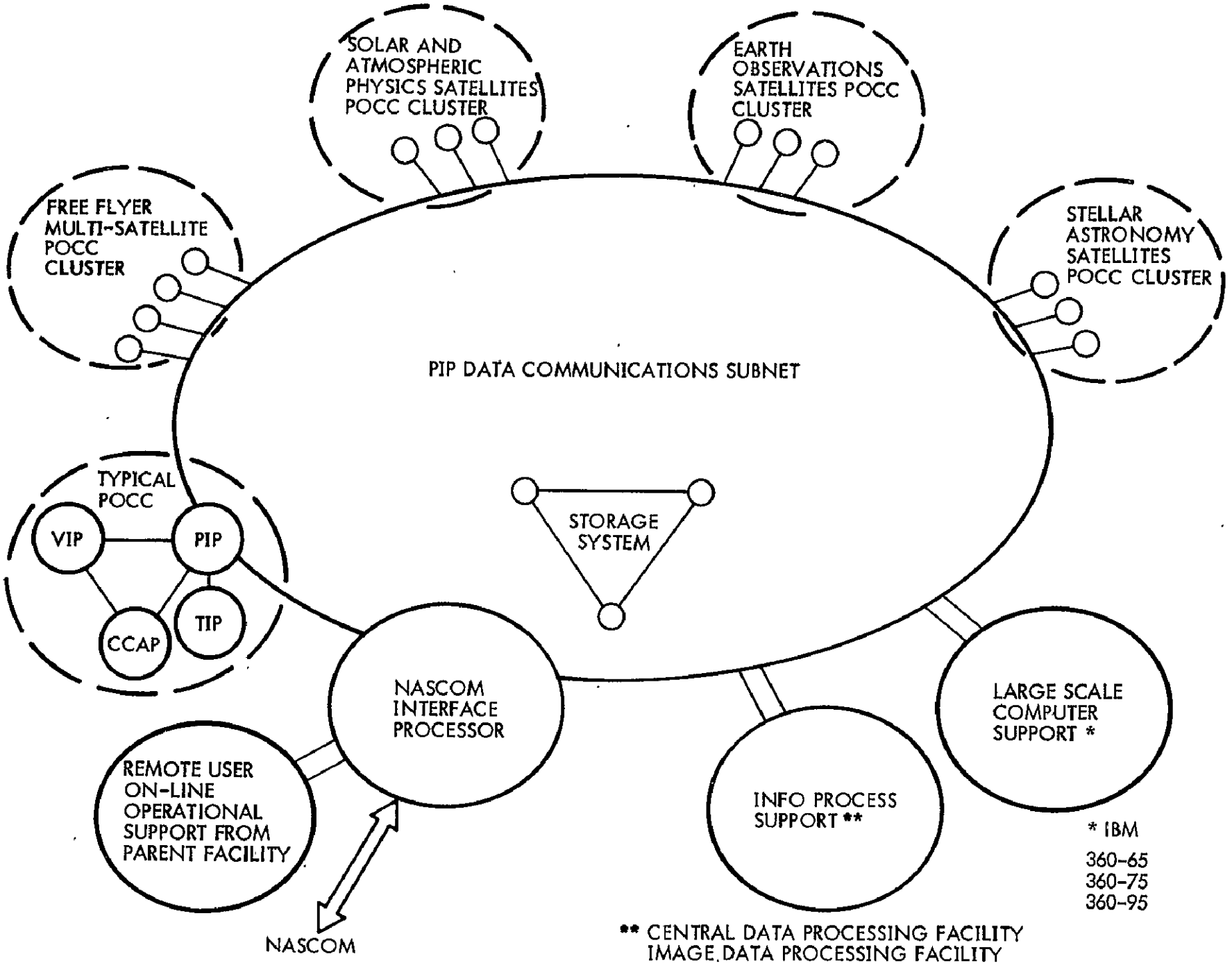
- COMMUNICATE WITH POCC VIA DOMSAT
- IS AN EXTENSION OF POCC FUNCTIONS
- MONITORS SYSTEM STATUS
- PROVIDES REAL TIME DISPLAY
- HARD COPY TRANSFER
- COMMAND REQUEST TO POCC
- HANDLES DATA TO AND FROM USER
- DEPENDS ON USER FOR SCIENCE ANALYSIS
- DEPENDS ON POC FOR ENGINEERING ANALYSIS

POSSIBLE POCC IMPLEMENTATION APPROACHES

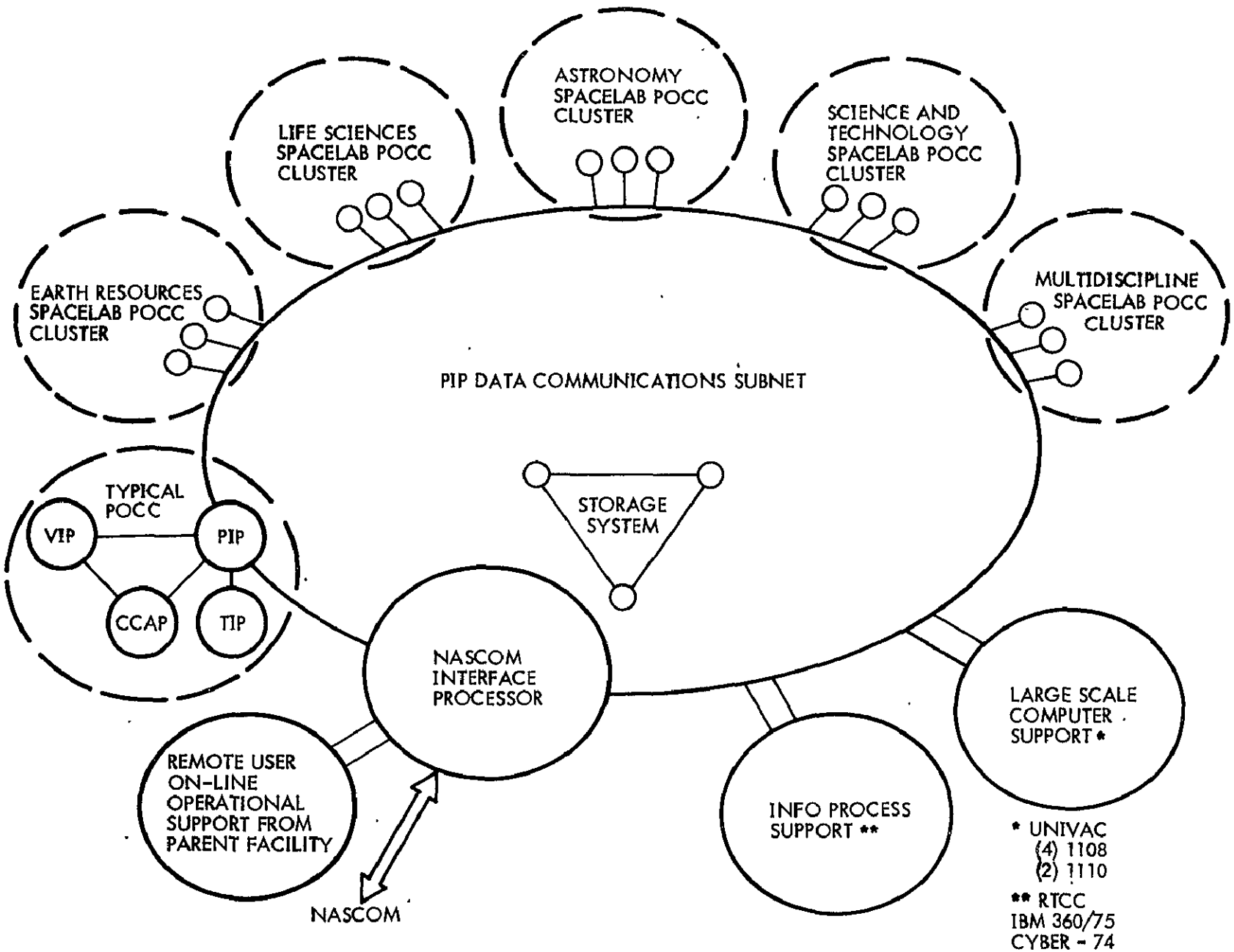
ALTERNATIVE V - FULLY CENTRALIZED, DEDICATED POCC'S

- EACH POCC IS AUTONOMOUS FOR PROJECT OR SCIENCE DISCIPLINE
- POCC'S ARE CUSTOMIZED TO MEET UNIQUE PROJECT OR DISCIPLINE NEEDS
- INSTITUTIONAL RESOURCES MAY BE COMMITTED TO POCC SUPPORT
- POCC INTEGRATES USER/DEVELOPMENT CENTER REQUIREMENTS FOR HARDWARE/ SOFTWARE CONFIGURATION AND OPERATIONS
- THIS ALTERNATIVE MOST APPLICABLE TO LARGE, COMPLEX, LONG DURATION PROJECTS

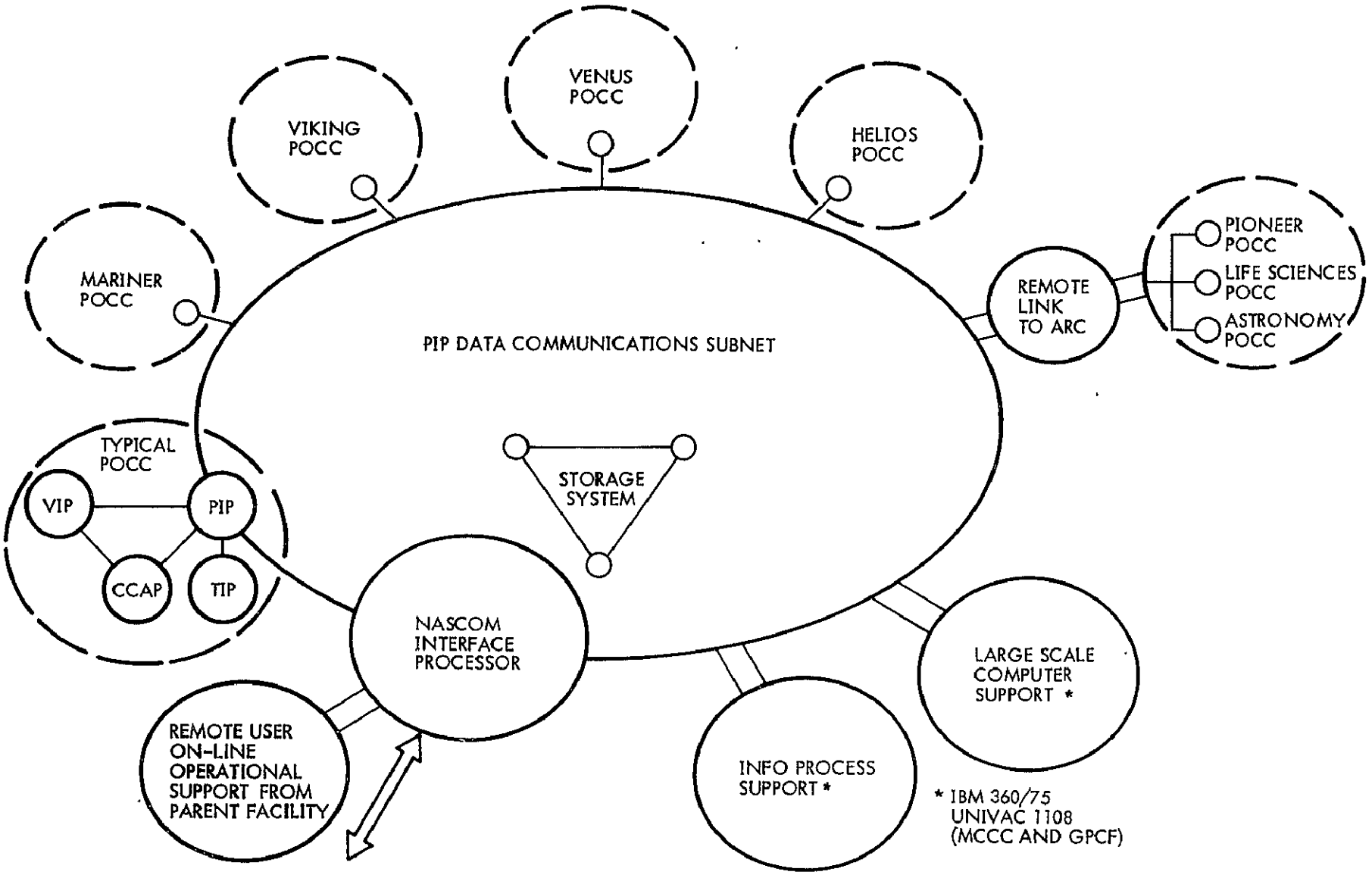
GSFC PAYLOAD OPERATIONS CENTER CONCEPT



JSC PAYLOAD OPERATIONS CENTER CONCEPT

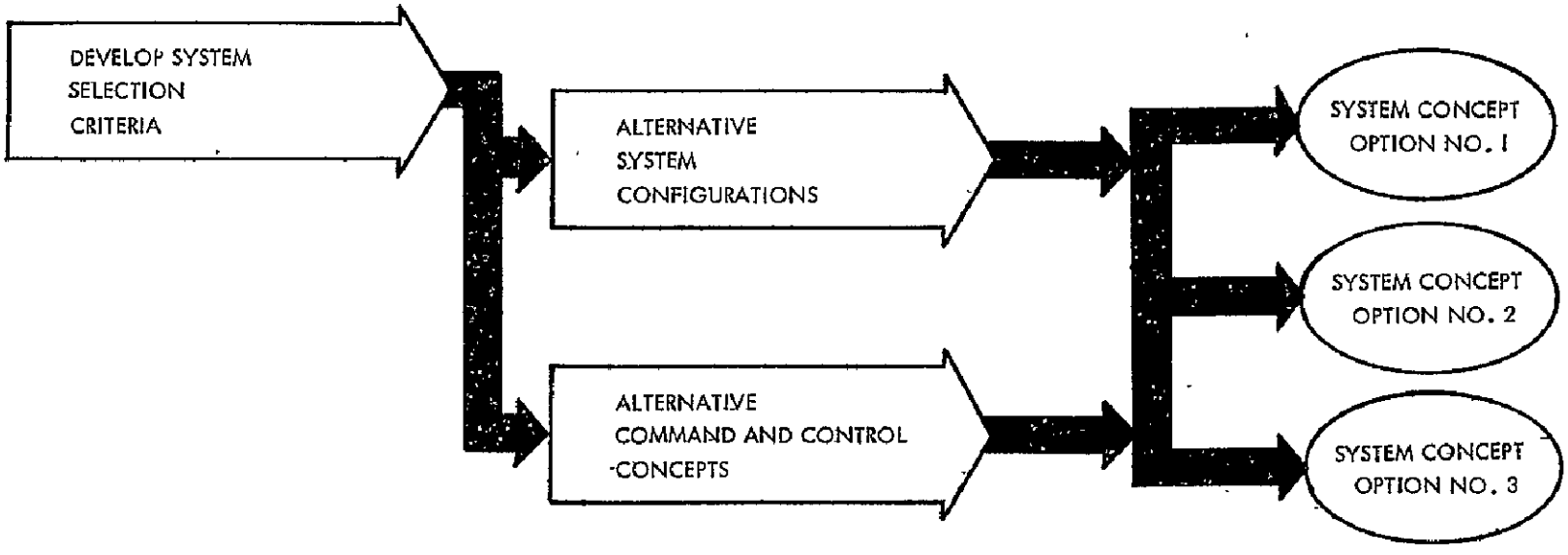


JPL PAYLOAD OPERATIONS CENTER CONCEPT



SYSTEM CONCEPT OPTIONS

SYSTEM CONCEPT OPTION SELECTION FLOW

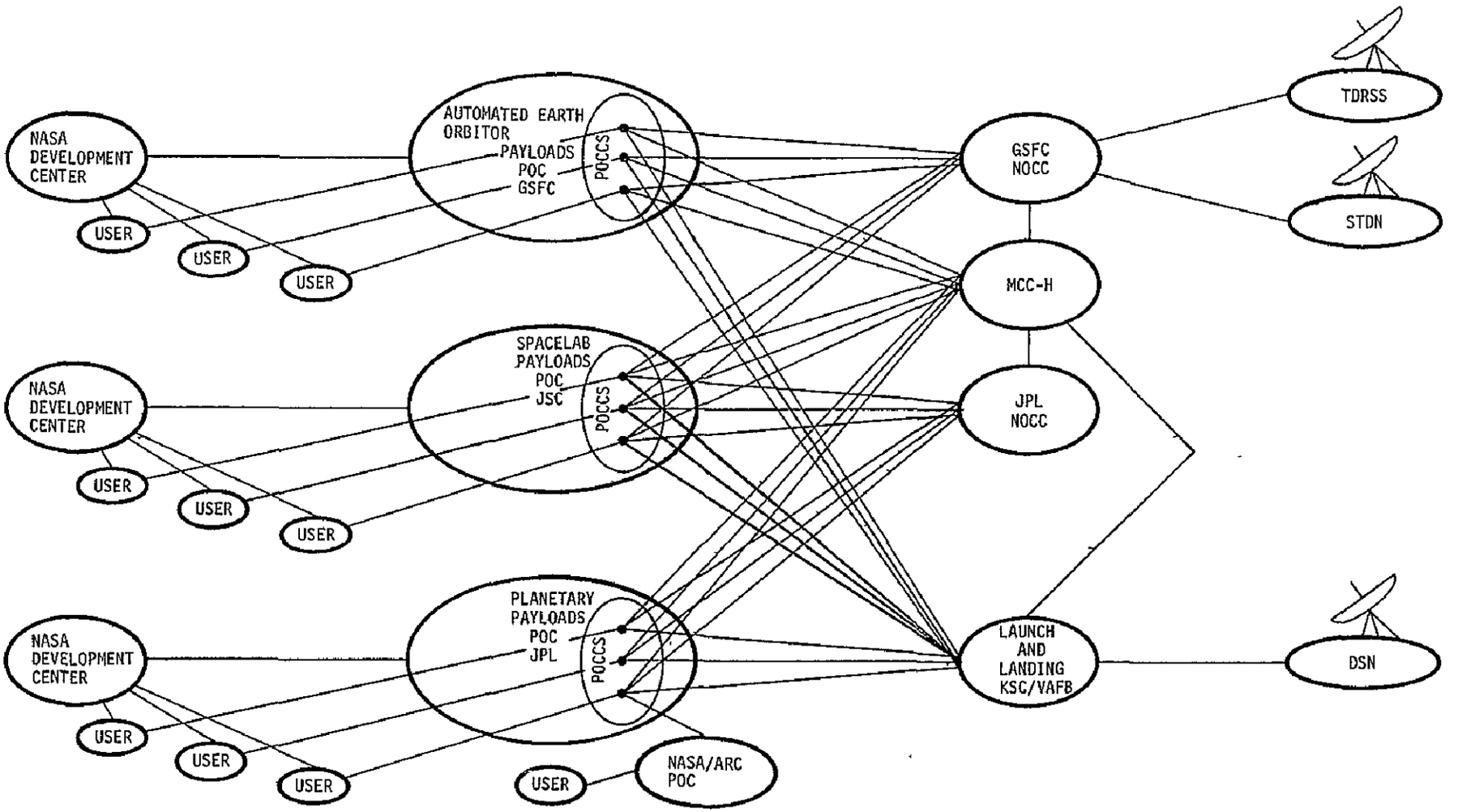


CONCEPT	CHARACTERISTIC
I	- EXISTING POC'S
II	- GSFC AND JSC SHARE FUNCTIONS - PAYLOAD COORDINATOR
III	- PORTABLE POCC'S - INTEGRATED OPERATIONS MANAGER

SELECTION CRITERIA FOR SYSTEM CONCEPT OPTIONS

- COST FACTORS
  - NON-RECURRING
  - RECURRING
- OPERATIONAL EFFECTIVENESS
  - COMPLEXITY OF INTERFACES
  - FACTORS TO ENHANCE CREW SAFETY
  - FACILITY LOADING EFFICIENCY
- RESPONSIVENESS TO USERS
  - ACCESSIBILITY OR UTILITY TO USERS
  - ACCESSIBILITY TO ENGINEERING SUPPORT

JOINT STS/PAYLOAD FLIGHT CONTROL SYSTEM CONCEPT OPTION NO. I



JOINT STS/PAYLOAD FLIGHT CONTROL SYSTEM CONCEPT OPTION NO. I

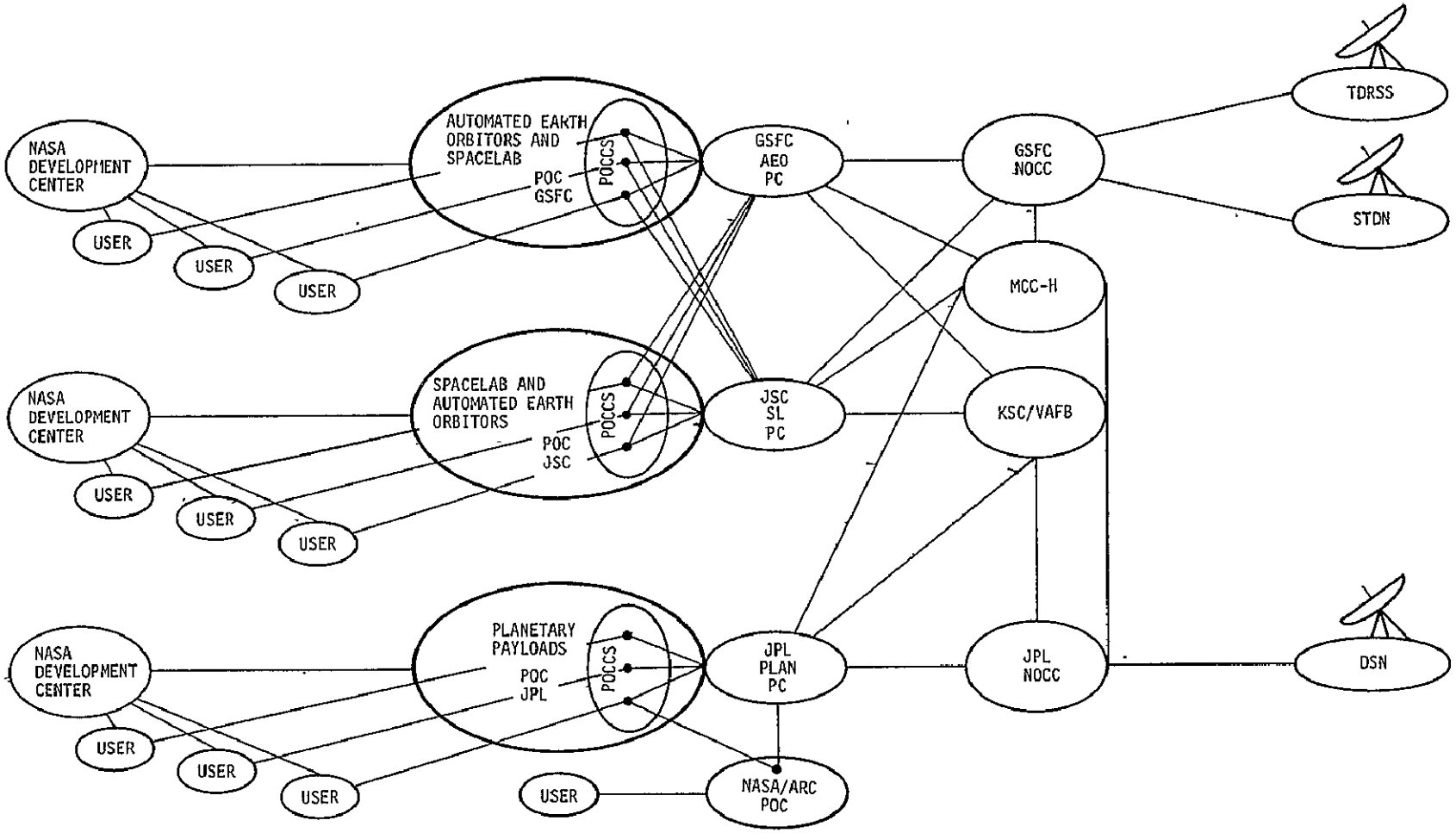
ADVANTAGES

- MEETS INITIAL REQUIREMENTS AT MINIMUM COST
- MAKES MAXIMUM USE OF CENTERS' EXISTING CAPABILITIES AND EXPERIENCE
- REQUIRES MINIMUM CHANGES TO PRESENT MODE OF PAYLOAD OPERATIONS
- PROVIDES A SOLID BASELINE FOR FUTURE SYSTEM ENHANCEMENTS
- WILL PROVIDE FOR EASY TRANSITION TO STS PAYLOAD OPERATIONS
- MEETS CONCEPT SELECTION CRITERIA FOR STUDY

DISADVANTAGES

- INITIALLY HAD LIMITED STANDARDIZATION
- SLOW TURN-AROUND TIME
- SEPARATE NETWORK CONTROL
- MULTIPLICITY OF INTERFACES

JOINT STS/PAYLOAD CONTROL SYSTEM CONCEPT OPTION NO. 2



JOINT STS/PAYLOAD CONTROL SYSTEM CONCEPT OPTION NO. 2

ADVANTAGES

- HAS PAYLOAD COORDINATOR FOR EACH PAYLOAD CLASS
- REDUCES NUMBER OF OPERATIONAL INTERFACES
- ENABLES HIGHER DEGREE OF STANDARDIZATION OF OPERATIONS
- INCREASED VERSATILITY FOR SPACELAB AND AEO PAYLOAD OPERATION

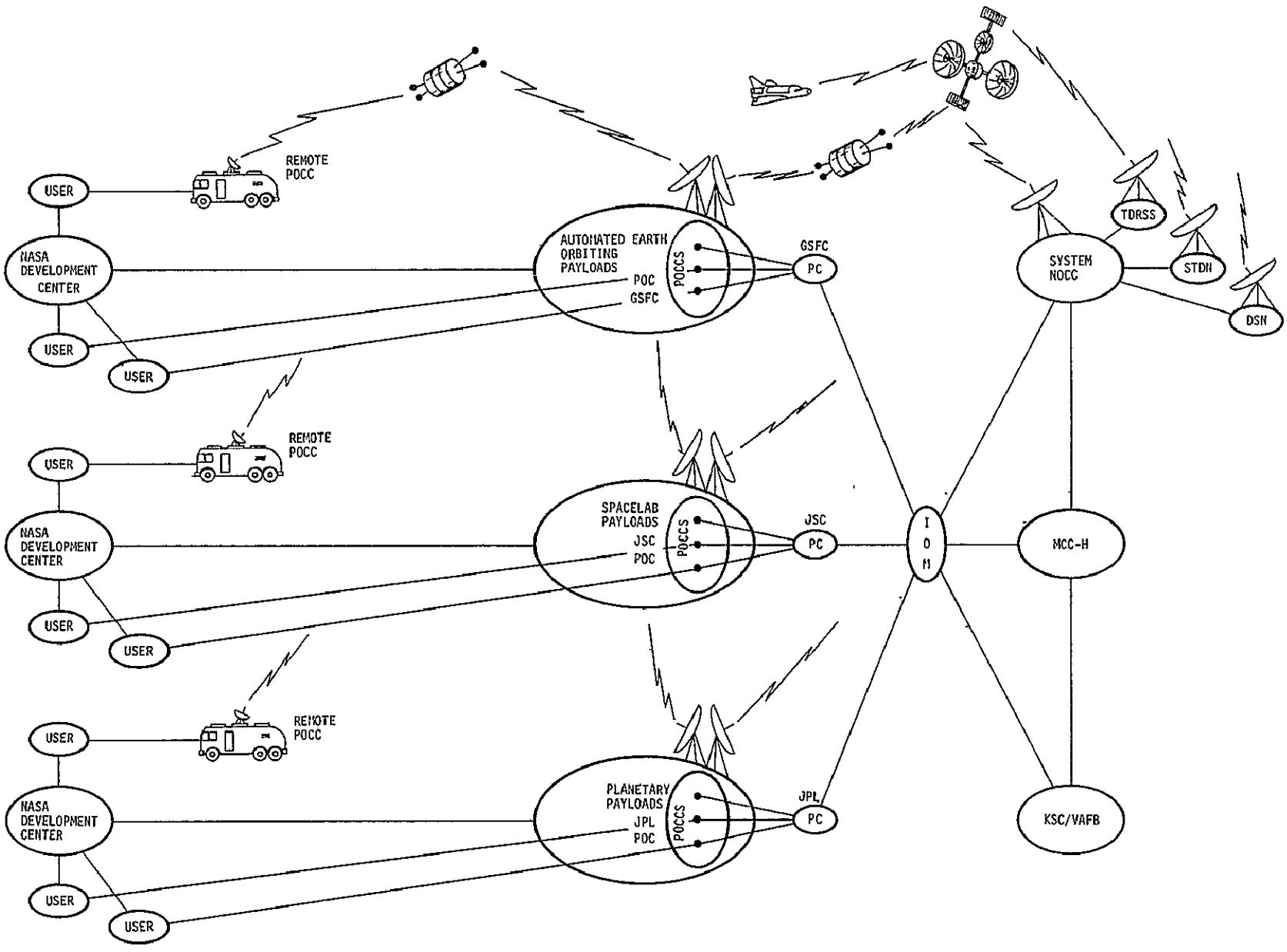
DISADVANTAGES

- SEPARATE NETWORK CONTROL
- LACKS PROVISIONS FOR EFFICIENT REMOTE POCC'S

FUNCTIONS OF PAYLOAD COORDINATORS, (PC'S) FOR EACH PAYLOAD CLASS

- FUNCTION RESIDES AT POC FOR EACH PAYLOAD CLASS
- COORDINATES OPERATIONS BETWEEN CENTERS AND POCC'S FOR ALL PAYLOADS OF A GIVEN CLASS
- INSURES STANDARDIZATION OF OPERATIONS FROM FLIGHT TO FLIGHT
- PROVIDES SINGLE POINT INTERFACE WITH MCC-H
- RESOLVES CONFLICTS OF RESOURCES REQUIREMENTS BETWEEN PROGRAMS
- ASSISTS IN RESOLVING CONTINGENCIES AFFECTING TWO OR MORE PAYLOADS
- MAINTAINS SCHEDULE AND STATUS OF ALL OPERATIONS OF A GIVEN PAYLOAD CLASS
- OPERATES FROM CONSOLE WITHIN AN ASSIGNED POCC

JOINT STS/PAYLOAD FLIGHT CONTROL SYSTEM CONCEPT OPTION NO. 3



JOINT STS/PAYLOAD CONTROL SYSTEM CONCEPT OPTION NO. 3

ADVANTAGES

- PROVIDES FOR EFFICIENT REMOTE POCC'S
- HAS INTEGRATED NETWORK CONTROL (SYSTEM NOCC)
- INTEGRATED OPERATIONS MANAGER PRESENTS SINGLE STANDARD PAYLOAD INTERFACES TO MCC-H, SYSTEM NOCC, LAUNCH/LANDING SITES
- ACCOMODATES STANDARD OPERATIONAL PROCEDURES/CONVENTIONS IN OPTIMUM WAY

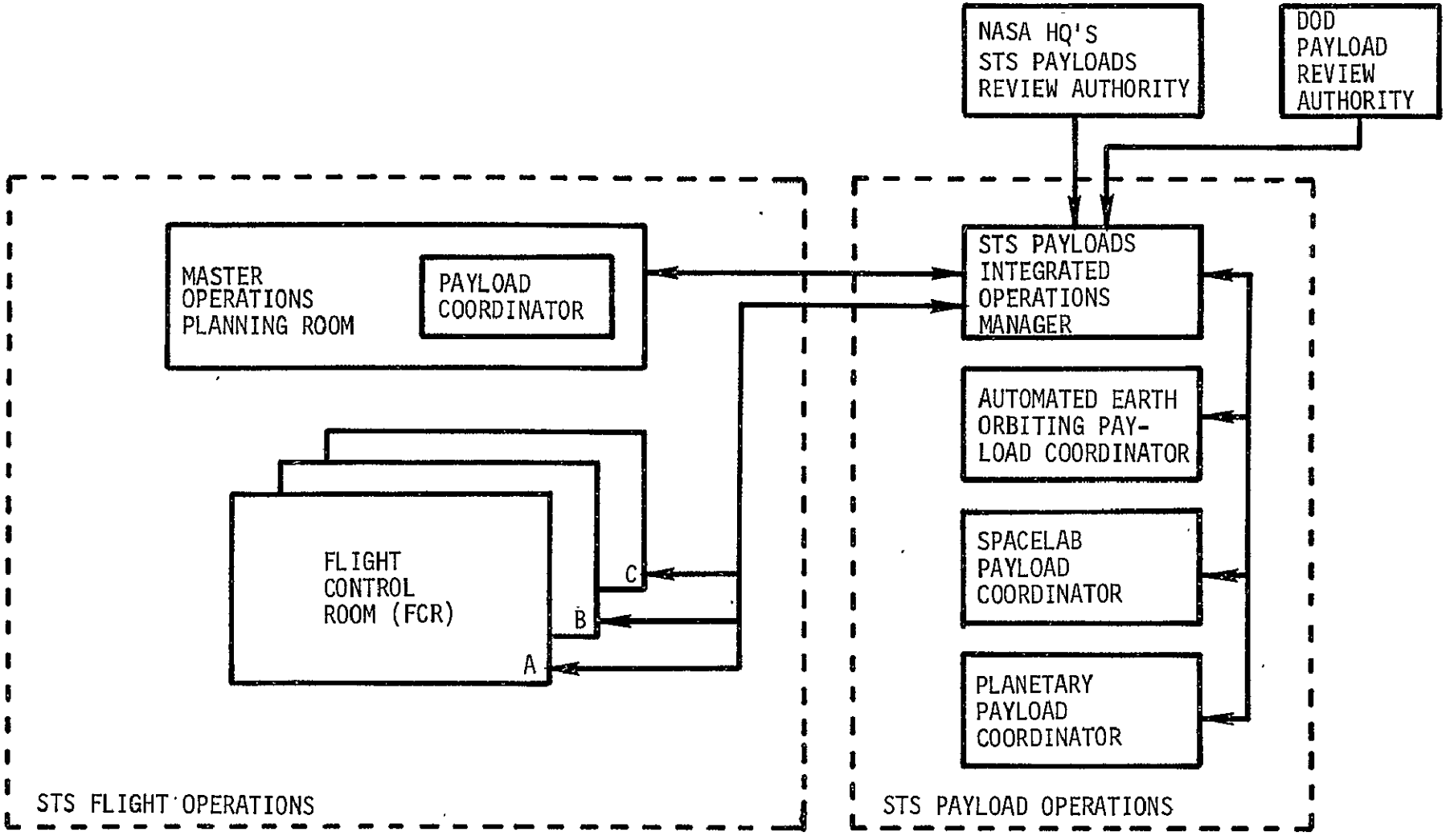
DISADVANTAGES

- LENGTHENED LINES OF COMMUNICATION VIA IOM AND PC
- PORTABLE POCC'S INTRODUCE OPERATIONAL COMPLEXITY

FUNCTIONS OF THE PAYLOAD INTEGRATED OPERATIONS MANAGER

- LOCATED AT JSC BUT NOT ORGANIZATIONALLY ATTACHED
- PROVIDES THE REAL TIME PAYLOAD OPERATIONAL INTERFACE WITH NASA HEADQUARTERS
- ASSISTS STS FLIGHT OPERATOR IN DEVELOPING INTEGRATED FLIGHT PLAN
- MONITORS INTEGRATED FLIGHT PLAN DURING EXECUTION
- PROVIDES SINGLE POINT INTERFACE WITH STS FLIGHT OPERATOR TO COORDINATE REAL TIME OPERATIONS WITH PAYLOAD CLASSES AND DOD PAYLOADS
- COORDINATES PAYLOAD OPERATORS IN MAKING CHANGES IN OPERATIONS TIMELINES FOR MULTI-CARGO MISSIONS
- RESOLVES CONTINGENCY OPERATIONS BETWEEN PAYLOAD CLASSES
- INSURES STANDARDIZATION OF PROCEDURES, FORMATS FOR OPERATIONAL INTERFACES OF ALL PAYLOAD CLASSES
- RESOLVES CONFLICTS OF REQUIREMENTS BETWEEN PAYLOAD CLASSES DURING REAL TIME OPERATIONS
- MAINTAINS SCHEDULE AND STATUS ON ALL PAYLOADS AND ASSESSES IMPACT OF REAL TIME OPERATIONAL CHANGES ON OTHER SCHEDULED OPERATIONS

STS PAYLOAD OPERATIONAL INTERFACES WITH STS FLIGHT OPERATIONS



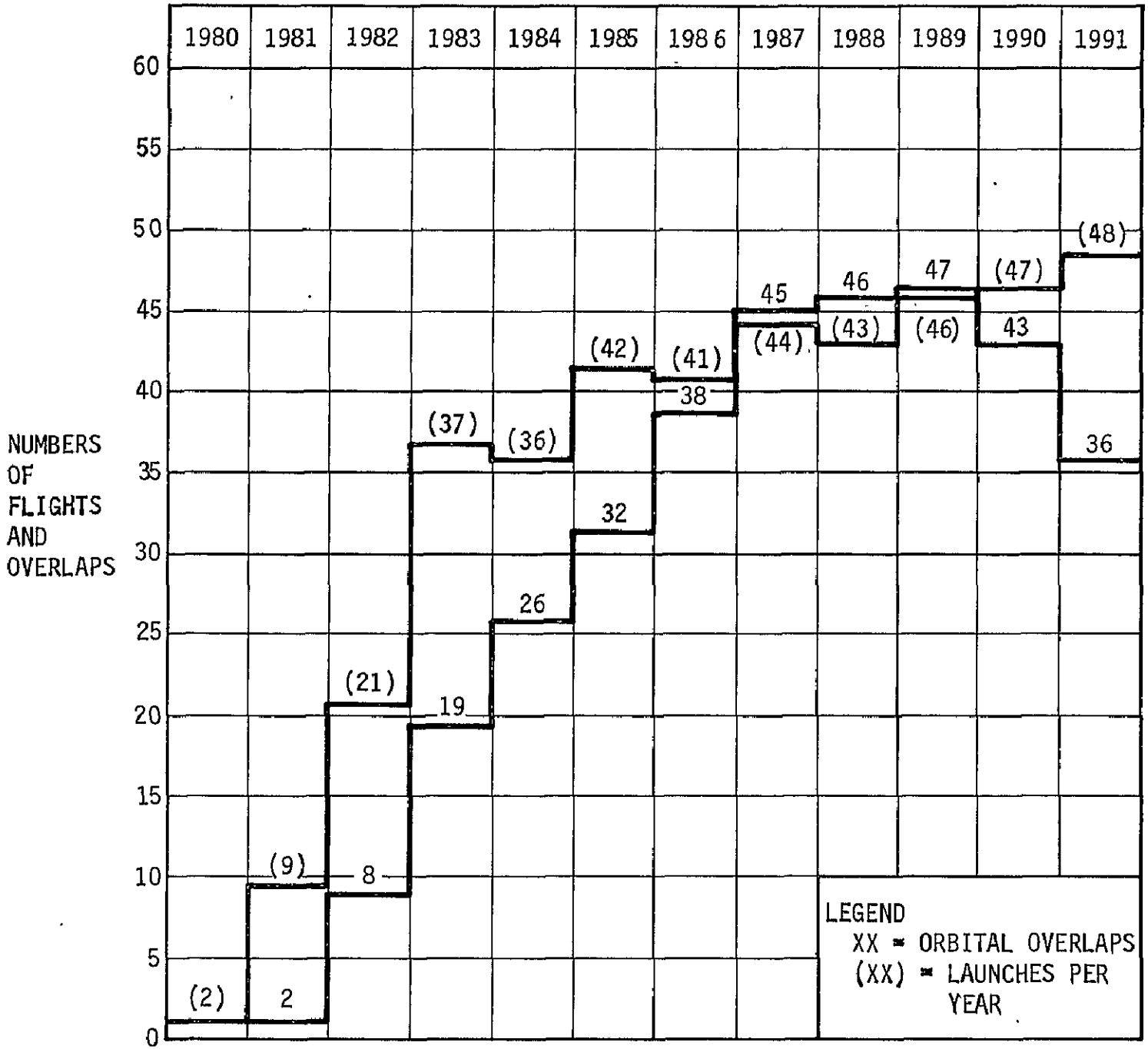
STS PAYLOAD OPERATIONS IMPLEMENTATION GUIDELINES

STS PAYLOAD OPERATIONS IMPLEMENTATION GUIDELINES

MAJOR DRIVERS FOR PAYLOAD OPERATIONS IMPLEMENTATION ARE:

DRIVER	FACTORS
• COST	- USE EXISTING CAPABILITIES - STANDARDIZATION OF SYSTEMS AND PROCEDURES
• FLIGHT RATE BUILD-UP	- TIME PHASED IMPLEMENTATION - IMPROVED SYSTEM TURN-AROUND TIMES - ENHANCED DATA HANDLING CAPABILITIES
• INCREASING NUMBERS OF FLIGHT OVERLAPS	- MULTIPLE RESOURCES FOR DATA HANDLING, COMPUTATION, AND TEAM STRUCTURES - DATA COMPRESSION/FILTERING AT SOURCES
• COMMON PAYLOAD INTERFACES WITH MCC-H	- STANDARD OPERATING INTERFACES AND PROCEDURES
• ACCOMMODATION OF SPACELAB PAYLOADS	- SPACELAB PAYLOADS LARGEST SINGLE CLASS - ALL SHORT DURATION - ALL POCC'S STANDARD AND CAPABLE OF SPACELAB PAYLOAD SUPPORT

ANALYSIS OF TRAFFIC MODEL AND FLIGHT OVERLAPS

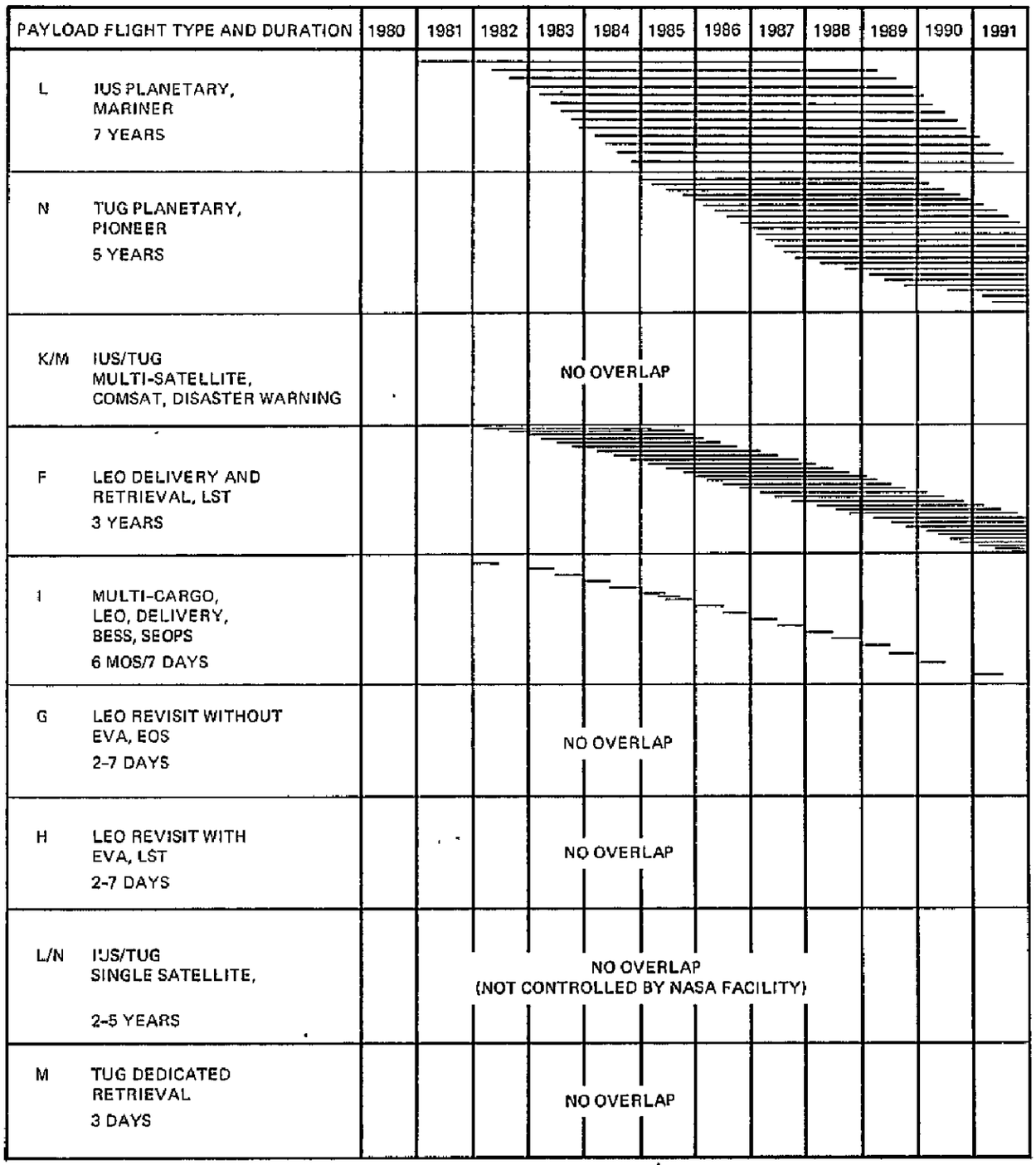


DURATION OF STS OPERATIONS SHOWING OVERLAPS

PAYLOAD FLIGHT TYPE AND DURATION	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
A SPACELAB MODULE AND PALLET – ATL 7-30 DAYS							NO OVERLAP					
A SPACELAB MODULE AND PALLET – AMPS 7-30 DAYS							NO OVERLAP					
C SPACELAB PALLET ONLY, SO 7-30 DAYS							NO OVERLAP					
C SPACELAB PALLET ONLY – STELLAR 7-30 DAYS							NO OVERLAP					
B SPACELAB MODULE AND PALLET MULTI-DISCIPLINE 7-30 DAYS	◄						NO OVERLAP				(2)*	(2)*
D SPACELAB, PALLET ONLY, MULTI-DISCIPLINE 7-30 DAYS							NO OVERLAP					
J SPACELAB MODULE ONLY, DEDICATED DISCIPLINE L S 7-30 DAYS							NO OVERLAP					
J MULTI-CARGO DELIVERY – EXPLORER/ STP 2 YEARS												

*ASSUME 6 SHUTTLE FLIGHTS PER YEAR WITH NO OVERLAP, HOWEVER 2 OVERLAPPING PL OPERATIONS DUE TO 7 FLIGHTS IN 1990 AND 8 FLIGHTS IN 1991.

DURATION OF STS OPERATIONS SHOWING OVERLAPS (Continued)

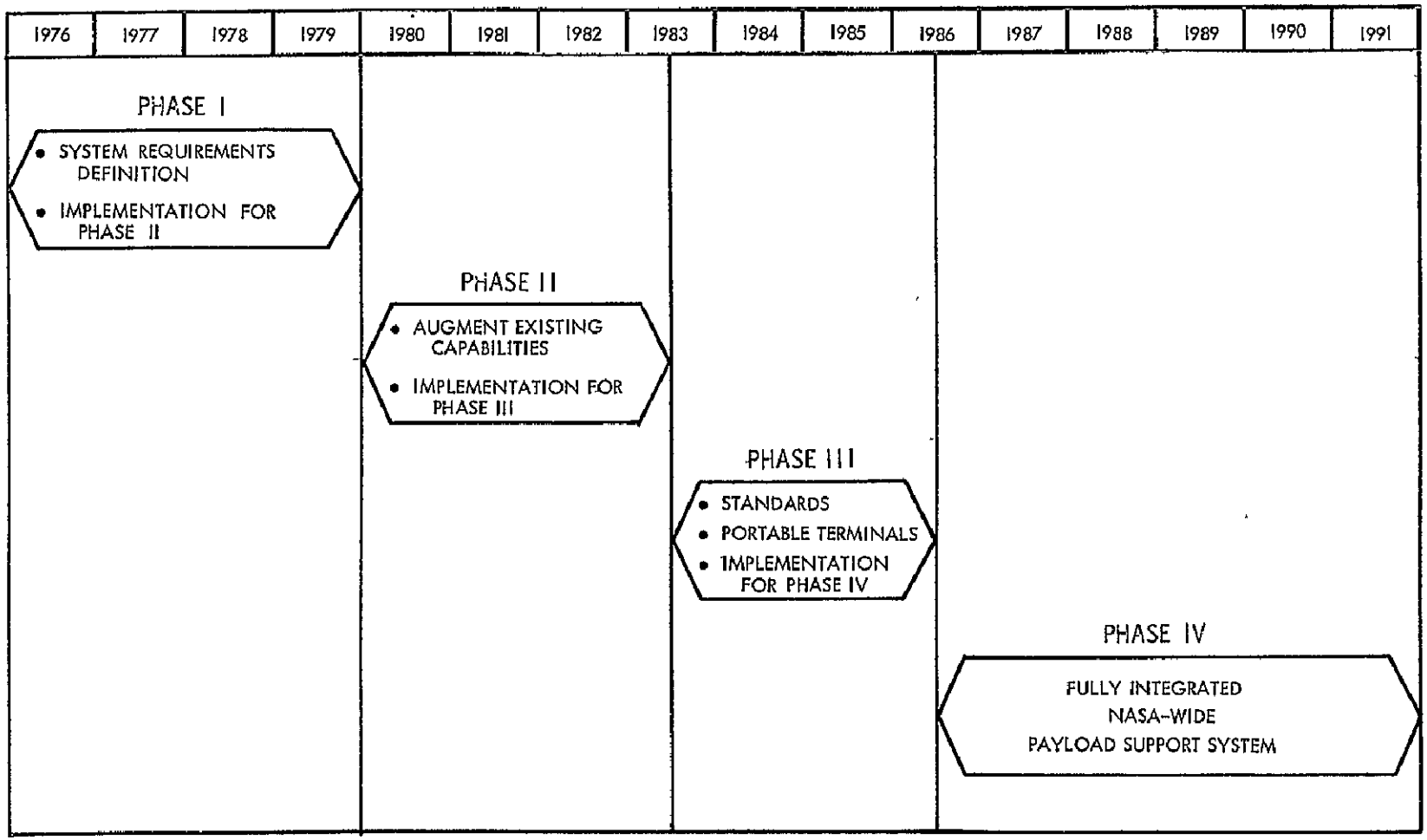


STS PAYLOAD OPERATIONS IMPLEMENTATION GUIDELINES AND CONSIDERATIONS

IMPLEMENTATION RATIONALE

- START WITH EXISTING SYSTEM, CONCEPT NO. 1
- GROW TOWARDS CONCEPT CONFIGURATION NO. 2 OR NO. 3 AS SYSTEM LOADING DICTATES
- EMPLOY A TIME PHASED EVOLUTIONARY BUILDING BLOCK APPROACH
- MEET EXPANDING LOADS BY INCREASING EFFICIENCY RATHER THAN ADDING POCC'S. ACHIEVE THROUGH:
  - STANDARDIZATION
  - IMPROVED UTILIZATION
  - POCC VERSATILITY
  - FIRMWARE VERSUS SOFTWARE
  - INTEGRATION OF SEPARATE CAPABILITIES
- A PRACTICAL APPROACH SUGGESTS EVOLVING FROM PRESENT SYSTEM TOWARD A INTEGRATED, SYSTEM FOR STS PAYLOAD SUPPORT

STS PAYLOAD OPERATIONS IMPLEMENTATION PHASES



PAYLOAD OPERATIONS IMPLEMENTATION GUIDELINES AND CONSIDERATIONS

PHASE I - 1976 TO 1980 - REQUIREMENTS DEFINITION - IMPLEMENTATION OF BASELINE SYSTEM

- COMPLETE STUDIES TO DEFINE NASA-WIDE STS PAYLOAD SYSTEM INTEGRATION AND IMPLEMENTATION APPROACH.
  - REFINE PAYLOAD REQUIREMENTS FOR LONG RANGE SUPPORT
  - DEFINE PAYLOAD STANDARDS FOR COMMUNICATIONS, DATA FORMATS, COMMAND SYSTEMS, POCC'S.
  - TECHNOLOGY ASSESSMENT STUDIES - STANDARD FIRMWARE TO REPLACE SOFTWARE.
  - DEFINE HOST FACILITIES TO PROVIDE STANDARD USER SUPPORT FUNCTIONS AND INTERFACES.
  - INVESTIGATE IMPLEMENTATION OF PORTABLE REMOTE POCC OR DATA MONITORING FACILITY WITH DOMSAT TERMINAL.
  - MAKE TRADE-OFFS FOR EXPANSION OF THREE CENTER BASELINE SYSTEM CAPABILITIES VS ADDITIONAL CENTERS AS PAYLOAD OPERATIONS CENTERS.
  - DETERMINE IMPLEMENTATION APPROACH FOR STANDARD DATA TRANSFER CAPABILITY BETWEEN CENTERS.
  - DEFINE A SUPERVISORY CENTERWIDE DATA BASE MANAGEMENT SYSTEM FOR PAYLOAD OPERATIONS.
  - DEFINE A STANDARD POCC WITH QUICK TURN-AROUND CAPABILITY.
  - ESTABLISH STANDARDS AND REQUIREMENTS FOR DATA COMPRESSION FOR LONG TERM HIGH DATA RATE PAYLOADS.
- DESIGN AND IMPLEMENT SPACELAB POCC CAPABILITIES.
- AUGMENT BASELINE CENTERS FOR PAYLOAD SUPPORT IN ACCORDANCE WITH EXISTING PLANS FOR SUPPORT OF PHASE II PAYLOADS. THIS INCLUDES TDRSS GROUND COMMUNICATION SUPPORT CAPABILITY.
- BEGIN INTRODUCING STS PAYLOAD STANDARDS TO BE EFFECTIVE IN PHASE III AND IV.

PAYLOAD OPERATIONS IMPLEMENTATION GUIDELINES AND CONSIDERATIONS

PHASE II — 1980 TO 1983 — BASELINE SYSTEM — AUGMENTED EXISTING CAPABILITY; IMPLEMENTATION FOR PHASE III.

- INTRODUCE DOMSAT TERMINALS AT POCS.
- INTEGRATE CONTROL AND SCHEDULING OF ALL PAYLOAD TRACKING AND DATA ACQUISITION FACILITIES UNDER A SYSTEM NOCC.
- INTRODUCE FULLY COMPATIBLE SYSTEM FOR INTERCENTER DATA TRANSMISSION.
- ESTABLISH SUPERVISORY DATA BASE MANAGEMENT SYSTEM UNDER CENTRAL AUTHORITY.
- IMPOSE STANDARDS FOR DATA FORMATS, COMMAND SYSTEMS AND STRIPPING/PROCESSING DATA FOR STS PAYLOADS.
- INTRODUCE STANDARD OPERATING PROCEDURES FOR
  - REAL TIME MODIFICATION OF FLIGHT PLANS
  - PRIORITY SCHEMES FOR RESOLVING CONFLICTS IN RESOURCES REQUIREMENTS
  - AUTOMATED SCHEDULING SYSTEMS
  - COMPUTERIZED DOCUMENTATION GENERATION AND UPDATE
  - HIGH SPEED, HIGH RESOLUTION FACSIMILE FOR TRANSFER OF HARD COPY BETWEEN REMOTE OPERATORS.
- ESTABLISH OPERATIONAL INTERFACES WITH VAFB.

PAYLOAD OPERATIONS IMPLEMENTATION GUIDELINES AND CONSIDERATIONS

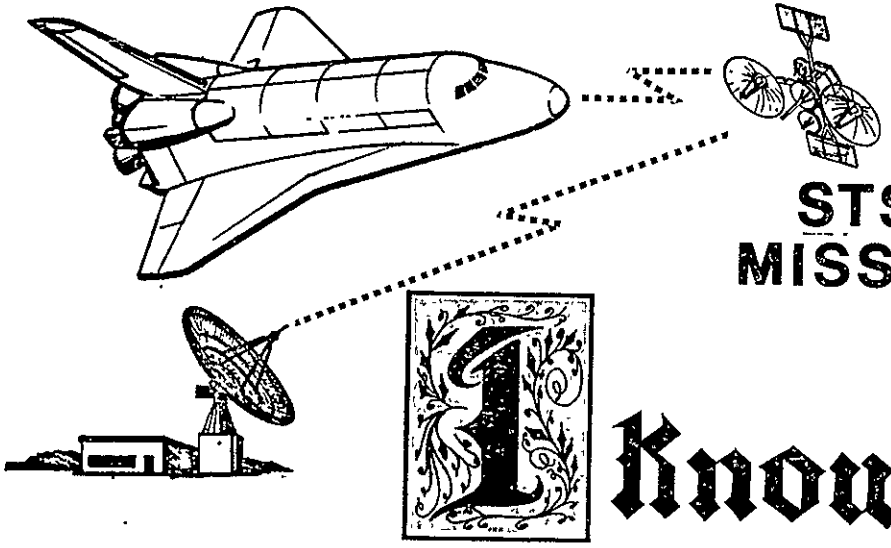
PHASE III - 1983 TO 1986 - TRANSITION PHASE - IMPLEMENTATION FOR PHASE IV

- PHASE IN STANDARD OPERATING CONSOLE MODULES AT ALL POCC'S.
- INTRODUCE STANDARD DISPLAY SYSTEMS FOR ALL POCC'S.
- IMPLEMENT STANDARD POCC DESIGNS NECESSARY FOR ANY POCC TO SUPPORT ANY PAYLOAD AND TO PERMIT RECONFIGURATION WITHIN 10 TO 15 DAYS.
- IMPLEMENT STANDARD USER INTERFACES WITHIN HOST FACILITIES FOR USERS TO ACCESS THE INTEGRATED SYSTEM.
- PROVIDE A SYSTEM OF PORTABLE POCC/DOMSAT TERMINALS TO INTERFACE REMOTE CENTERS OR USER FACILITIES WITH HIGH DATA RATE REQUIREMENTS INTO THE NASA SYSTEM.

PAYLOAD OPERATIONS IMPLEMENTATION GUIDELINES AND CONSIDERATIONS

PHASE IV - MID 1986 THROUGH 1991 - FULLY INTEGRATED NASA-WIDE STS PAYLOAD SUPPORT SYSTEM.

- SYSTEM SUPPORTS FULL TRAFFIC MODEL.
- ALL SYSTEM ENHANCEMENTS COMPLETE AT BEGINNING OF PHASE IV.
- AN INTEGRATED NETWORK OF NASA PAYLOAD CENTERS WILL PROVIDE MAXIMUM FLEXIBILITY FOR RESPONSE TO CHANGES DURING REMAINDER OF STS OPERATIONAL ERA.



STS PAYLOADS MISSION CONTROL STUDY

I know you believe you understand what you think I said but, I am not sure you realize that what you heard is not what I meant

TRW
SYSTEMS GROUP